OCTOBER 1916.] [Price 6s.

PROCEEDINGS

OF THE

LINNEAN SOCIETY OF LONDON.

128TH SESSION.

FROM NOVEMBER 1915 TO JUNE 1916.

LONDON:
PRINTED FOR THE LINNEAN SOCIETY,
BURLINGTON HOUSE, PICCADILLY, W.,
BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

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PUBLICATIONS: July 1915–August 1916.

Journal, Botany.

Vol. XLIII.	No. 289.	5/-
„ „	„ 290.	12/-
„ „	„ 291.	22/-

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Proceedings, 127th Session, October 1915. 10/-

List of [Fellows, Associates, and Foreign Members], Nov. 1915.

PROCEEDINGS

OF THE

LINNEAN SOCIETY OF LONDON.

(ONE HUNDRED AND TWENTY-EIGHTH SESSION, 1915–1916.)

November 4th, 1915.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 17th June, 1915, were read and confirmed.

Miss Lilian Lyle was admitted a Fellow.

Mr. Mohamad Maula Baksh, B.A. (Oxon.), Dr. Alfred Bishop Hitchins, Mr. Thottakat Narayana Menon, and Mr. Robin John Tillyard, M.A., B.Sc., F.E.S., were proposed as Fellows.

The President gave notice that the next General Meeting on the 18th November would be made special, for electing three Councillors and a Secretary for Zoology, in the place of Dr. Richard Assheton, Prof. D. T. Gwynne-Vaughan, and Prof. E. A. Minchin, Sec.L.S., deceased.

He further moved a vote of sympathy with Mrs. Minchin on the loss of her husband—a loss to Science, and a great loss to the Society,—which was unanimously carried, the Fellows rising in their places.

The paper entitled "The Foraminifera of the West of Scotland, collected by Prof. W. A. Herdman, F.R.S., on board the

S.Y. 'Runa,' 1913," by Edward Heron-Allen, F.L.S., F.Z.S., F.G.S., F.R.M.S., and Arthur Earland, F.R.M.S., was summarized by Mr. E. Heron-Allen.

Prof. W. A. Herdman and Sir Henry Howorth (visitor) contributed to a discussion which followed, Mr. E. Heron-Allen briefly replying.

November 18th, 1915.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 4th November, 1915, were read and confirmed.

The Rev. Thomas Albert Jefferies was admitted a Fellow.

The President read a letter from Mrs. Minchin in reply to his communication of the vote of sympathy passed at the last Meeting.

The President then declared the Meeting a Special General Meeting in accordance with the Notice given on the 4th November, and the Fellows present proceeded to Ballot for three Members of Council and a Secretary.

The Ballot for the Councillors having been closed, the President appointed Mr. Wilfred Mark Webb, Mr. Thomas Alfred Dymes, and Prof. Trail, Scrutineers, and these having cast up the votes and reported to the President, he declared the result as follows:—Mr. Edward Thomas Browne, Mr. Edwin Stephen Goodrich, and Mr. Gerald Loder elected Members of Council.

The Ballot for a Secretary having been closed, the President appointed the same Scrutineers, and these having cast up the votes, reported to the President, who declared that Mr. Edwin Stephen Goodrich had been elected Secretary in the place of Prof. E. A. Minchin, deceased.

Mr. Wilfred Mark Webb, F.L.S., then exhibited a series of feathers from several species of Hornbill, etc., which were hollow-shafted, and showed the proof of this by experiments and sections.

Dr. E. J. Salisbury, F.L.S., showed a series of lantern-slides, entitled "Photographic Studies of Welsh Vegetation," the following being an abstract of his accompanying remarks:—

I. The Vegetation of the Limestone. (*a*) The Limestone Cliffs; vegetation of *Festuca ovina* and hairy species, such as *Arabis hirsuta*, *Geranium sanguineum*, *Parietaria officinalis*; fleshy species

as *Brassica oleracea* and *Spergularia rupestris*; or leathery-leaved species, as *Thalictrum minus*, *Cotoneaster vulgaris*, and *Hedera Helix*. (*b*) Limestone pasture, with the dominant species *Festuca ovina*, accompanied by many of the common chalk-down species. Characteristic plants are *Helianthemum canum* f., *Spiræa Filipendula*, *Veronica spicata* var. *hybrida*, and *Spiranthes autumnalis*. Locally small woods of *Quercus sessiliflora* occur, though usually confined to siliceous soils. Exposure effect.

II. The Vegetation of the Siliceous Soils. (*a*) The *Quercus sessiliflora* woods, with associated trees as *Betula* spp. and *Pyrus Aucuparia*. Where the water-content is high, but the soil not acid, *Fraxinus* becomes common. As a result of felling or exposure *Betula pubescens* may become the dominant tree. The average light-intensity in summer is about 7·6 per cent. of the maximum diffuse illumination outside. The shrub layer is usually poor. The flora of the drier parts largely consists of heath species; in the wetter and more acid parts, *Vaccinium Myrtillus* is often abundant; towards the base of the slopes the ground flora is often almost entirely cryptogamic. Epiphytes as *Polypodium vulgare*, *Frullania* spp., and lichens are often abundant. In the valley bottom the *Quercus sessiliflora* woods merge into *Alnus* woods, with a light-intensity of about 3 per cent. or under. (*b*) Scrub chiefly of *Cratægus*.

III. The Subalpine Vegetation. (*a*) The subalpine lakes with *Subularia aquatica*, *Lobelia Dortmanna*, *Littorella lacustris*, and *Isoëtes*, with absence of marginal vegetation. (*b*) The subalpine pastures (*Nardus*, *Lycopodium* spp., etc.).

Mr. F. N. Williams, Mr. C. E. Salmon, Dr. A. P. Young, Prof. J. W. H. Trail, and Dr. O. Stapf took part in the discussion which followed, Dr. Salisbury replying.

December 16th, 1915.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 18th November, 1915, were read and confirmed.

Mr. Edward Thomas Browne, Mrs. Beatrice Stuart, and Miss Harriet May Robinson, were admitted Fellows.

Mr. Alexander Rodger was proposed as a Fellow.

Mr. Mohamad Maula Baksh, B.A. (Oxon.), Dr. Alfred Bishop Hitchins, Mr. Thottakat Narayana Menon, and Mr. Robin John Tillyard, M.A., B.Sc., F.E.S., were elected Fellows.

Mr. Edwin S. Goodrich, F.R.S., Sec.L.S., read a paper on the reproduction of *Protodrilus*, criticising the account given by

Prof. U. Pierantoni, according to whom there are in most species of the genus male and hermaphrodite individuals. By internal autofecundation the latter are said to fertilise some of their ova, the males only fertilising the ova which remain unfertilised when the genital products escape by dehiscence. The development of the spermatozoa in hermaphrodites is stated to be from cells with two nuclei, one of which fragments and produces the heads of a bunch of spermatozoa. These "cistosperms," therefore, are not the normal produce of the maturation of spermatogonia and conversion of spermatocytes, but arise by a process apparently unique in the animal kingdom.

Dr. Orton having recently discovered *Protodrilus flavocapitatus* at Plymouth, the author has been able to study large numbers at the Marine Biological Laboratory. The apparent males and females are about equal in size and number; but in ripe females spermatozoa can often be seen, and many of the ova are fertilised. Mr. Goodrich brought forward evidence that these spermatozoa are derived from the males, are not developed in the females, and that their presence is due to normal internal cross-fertilisation between the sexes.

Miss Marietta Pallis explained her paper, "The Structure and History of 'Plav,' the floating fen of the delta of the Danube" (which was communicated by Prof. A. C. Seward, F.R.S., F.L.S.).

A discussion followed, Dr. C. E. Moss, Dr. O. Stapf, Sec.L.S., the President, the General Secretary, and Prof. F. E. Weiss taking part, and the author replied.

Mr. T. A. Dymes read a paper entitled "On the Seed-mass and Dispersal of *Helleborus fœtidus*, Linn."

Prof. Weiss, Mr. H. St. J. K. Donisthorpe (visitor), Mr. Clement Reid, Mr. E. Step, and Mrs. Stuart engaged in a discussion, replied to by the author.

The General Secretary showed some slabs of "Figured Ebony" and samples of walking-sticks made from that material by Messrs. Henry Howell & Co., Ltd., of Old Street, Finsbury. The matter had been brought to his notice by Mr. M. White Stevens, who, as the result of his enquiries, came to the conclusion that the origin of this chance lot of wood in the docks was the Andaman Islands; if correct, this would point to the probability of the tree yielding this ebony being *Diospyros Kurzii*, Hiern, described by Mr. J. S. Gamble, in his 'Manual of Indian Timbers,' p. 458, as "Andaman Marble Wood or Zebra Wood," the wood hard, the heartwood streaked black and grey in more or less alternate layers; it is one of the most important trees of the Andamans, and of great value if it can be supplied in sufficient quantity and become known.

January 20th, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 16th December, 1915, were read and confirmed.

Mrs. Elsie Wilkins Sexton was proposed as a Fellow.

The President announced the death of Dr. John Medley Wood, an Associate of the Society, creating a vacancy.

Mr. Miller Christy, F.L.S., read a paper "On the Definition of 'Right' and 'Left' in relation to coiled, rolled, revolving, and similar objects: a Problem in Scientific Terminology," which was illustrated by specimens, models, and lantern-slides. He referred to such terms as "right" and "left," following or against the sun (in northern latitudes), "clock-wise" and "counter clock-wise," as used by biologists, and also cited terms used by mathematicians which could not be used by naturalists with any advantage. He advocated the usage postulated by Linnæus, in his 'Philosophia botanica,' p. 103, before he became confused and altered his definition to an absurdity, and recommended the use of the heraldic words "dextral" and "sinistral" as unambiguous terms.

Dr. Rendle, Mrs. Longstaff, Mr. H. N. Dixon, and Mr. F. N. Williams took part in the discussion which followed, and the author replied.

Mr. Horace W. Monckton, Treas. and V.-P., gave a communication on "Some Aspects of the Flora of the Bagshot District," illustrating it by specimens and lantern-slides of the scenery.

He stated:—This communication deals with the area occupied by the Geological Formation known as "The Main Mass of the Bagshot Sands." About half is in Surrey, the remainder being nearly equally divided between Berkshire and Hampshire. The more important places in the district are Wokingham, Ascot, Yately, Sandhurst, Bagshot, Chobham, Weybridge, Camberley, Winchfield, Farnborough, and Aldershot. The greater part was until recent times a tract of pine-woods, heaths, and peaty swamps, and its character was mainly due to the sandy nature of the Bagshot Formation and the gravels resting upon it. There is no lime in these strata and, though clay occurs in places, the soil is markedly different from that on the London Clay, which comes to the surface around the Bagshot district.

The flora of much of the area resembles that of the Oak-Birch-Heath Association ('Types of British Vegetation,' ed. by A. G.

Tansley, Cambridge, 1911, p. 101). Other parts fit in well with the Heath Association, *op. cit.* p. 105, though the author thinks that neither *Genista pilosa* nor *Juniperus communis* occur, and some species (such as the Broom. *Molinia*, *Galium saxatile*, *Senecio sylvaticus*, and *Serratula tinctoria*) are perhaps more abundant than is indicated in the list given by Mr. Tansley.

There are many tracts which may be described as partially reclaimed heath and on which we find *Polygala serpyllacea*, *Hypericum perforatum*, *Ulex minor*, *Genista tinctoria*, *Epilobium angustifolium*, *Galium verum*, *G. erectum*, *Scabiosa Succisa*, *Solidago Virgaurea*, *Anthemis nobilis*, *Euphrasia brevipila*, *Luzula multiflora*, *Juncus squarrosus*, etc.

Much of the high ground forms plateaux covered with gravel some 10 to 15 feet thick, and on it we find the usual heath-plants: considerable areas of *Vaccinium Myrtillus* with *Scilla nonscripta*, *Nepeta hederacea*, *Teucrium Scorodonia*, and in damp places rushes and *Polygonum Hydropiper*.

Illecebrum verticillatum is perhaps the most interesting plant found in the district. It was recorded by Mr. Druce in his 'Flora of Berkshire,' p. 416, and the author exhibited a specimen collected by himself last year. He also showed specimens of *Potentilla argentea*, *Galium uliginosum*, *Antirrhinum Orontium*, *Scutellaria minor*, *Rumex Hydrolapathum*, and *Epipactis media* of British botanists. In addition, a series of forms of *Hieracium*, and a new species, to be described by the Rev. E. F. Linton, F.L.S.

The last communication was a series of colour-photographs of Mollusca, shown by Mr. B. B. Woodward, F.L.S.

February 17th, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 20th January, 1916, were read and confirmed.

Mr. Mohamad Maula Baksh, B.A., was admitted a Fellow.

Mr. Wilfrid Omer Cooper and Colonel Herbert Edward Rawson, C.B., were proposed as Fellows, and Mr. George Edward Massee as an Associate.

Mr. Alexander Rodger was balloted for and elected a Fellow.

The President announced that there are now three vacancies in the list of our Foreign Members. These are due to the

decease of Prof. Ambrosius Arnold Willem Hubrecht, Hermann, Count Solms-Laubach, and Charles René Zeiller.

The first communication was by Miss Carlotta Herring-Browne, entitled "John Bartram: the Pioneer American Botanist," which was communicated by the President, and illustrated with lantern-slides.

The author stated that Bartram was born on the 23rd March, 1699, near Darby in County Delaware, Pennsylvania.

His old stone farm-house was built in 1731, soon after his thoughts by a chance occurrence during his labours had been turned to the structure of flowers. It was in the same year that his friend James Logan procured a copy of Parkinson's 'Theatrum' from England as a present for Bartram, and this gift decided him to make excursions after plants into Maryland and Delaware. Of strong and untiring frame, neither danger nor difficulty kept him back. To receive and grow his discoveries he began before the end of the year to lay out the garden, the charm of which was felt by Washington, Jefferson, and Franklin. Three years later, at Franklin's suggestion, Bartram sent his diaries to Peter Collinson, in London, who, as a Member of the Society of Friends, had connections with Pennsylvania. This correspondence, to the mutual benefit of both, lasted till the death of the elder man in 1769. Through Collinson he became known to Linnæus, Gronovius, Dillenius, Sir Hans Sloane, Dr. Solander, Lord Petre, Dr. Fothergill, and others.

Many of the American trees were first sent to Europe by Bartram; amongst them being the *Taxodium distichum* still extant at Mill Hill, in Collinson's old garden. An even finer specimen, which died a few years ago, was 150 feet high, and 27 feet in girth; the trunk still stands in the Bartram Garden Park, Philadelphia.

In 1769 Bartram was elected a Member of the Royal Swedish Academy of Science at Stockholm, and the long letter he sent in acknowledgment is in the Society's possession among the Linnean correspondence.

Bartram died when the United States were one year old; he passed away in his old house, on the 22nd September, 1777. His life was shortened by the apprehension that his cherished garden might be laid waste by British troops, but his fears were not realized. This garden is now the property of the City of Philadelphia, and is supported as a public park. From time to time the members of the John Bartram Association, many of whom are his lineal descendants, meet to keep his memory green. The moss genus *Bartramia* is his botanical memorial.

The author has devoted many months to searching for memorials of Bartram among the archives in this country, and has succeeded in finding many most interesting letters and objects; these will be described in the complete work upon which she is engaged.

Miss May Rathbone, F.L.S., exhibited an Acorn producing twin plants, the two stems showing great differences in colour; the plants had been grown in water, as shown.

Dr. Rendle and Mr. W. C. Worsdell commented on this exhibition.

Mr. E. S. Goodrich, F.R.S., Sec.L.S., showed the Winter and Summer coloration of the Ermine, *Putorius ermineus*. He spoke of the various theories which had been suggested as the cause of this change, and dwelt upon that proposed by Metschnikoff, that phagocytes advanced up each hair as the effect of some stimulus, and destroyed the pigment, reducing the hair to white.

The President, the Rev. T. R. R. Stebbing, Mr. W. C. Worsdell, and Dr. A. P. Young discussed the phenomenon, and Mr. Goodrich replied.

The last paper was by Mr. E. P. Stebbing, "The Infestation of Bamboos in Tidal Waters by *Balanus amphitrite* and *Teredo navalis* in Tenasserim." In the absence of the author this was epitomised by the Zoological Secretary, who stated that the rapid destruction of bamboo piles was a serious loss, and the investigation showed that up to now no species of bamboo is immune; research is to be continued.

March 2nd, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 17th February, 1916, were read and confirmed.

Dr. James Charles McWalter was proposed as a Fellow, and Prof. Henri Lecomte, Paris, Prof. Edmond Perrier, Paris, and Prof. Pier' Andrea Saccardo, Padua, as Foreign Members.

Mrs. Elsie Wilkins Sexton was elected a Fellow.

Dr. Annie Porter, F.L.S., exhibited preparations of the diarrhœic stools of soldiers from Flanders, who were infested with *Giardia* (*Lamblia*) *intestinalis*, a Protozoön possessing two nuclei, eight flagella, and two axostyles, as well as a sucking-disc. The patients in each case had never been abroad until they went to Flanders, where the diarrhœic conditions were contracted. Blood was sometimes voided with the fæces, suggesting the presence of intestinal ulcers, as *Lamblia* occurred in the stool-blood. The infective stages or cysts of the parasite are ovoid bodies, about 10 μ to 15 μ by 7 μ to 9 μ, containing two or

four nuclei and sometimes the remains of the axostyles. The cysts give rise to two small flagellates when ingested with contaminated water or food by a new host. The flagellates attach themselves by the sucking-disc to the intestinal epithelium, particularly of the duodenum. After a time they contract, their flagella are withdrawn and disappear, and the resistant encysted forms, as exhibited, are produced. Similar parasites occur in rats and allied rodents, and it is very probable that these Protozoa can pass from rats to man by way of food contaminated with fæcal matter from the rodents. Rats constitute a great nuisance in the trenches in Flanders. Many other cases of lambliasis have been observed in Gallipoli, and in soldiers invalided therefrom. Careful watch should be made for recurrences of lambliasis among convalescents.

A discussion followed, in which the following took part:—Prof. Aldo Castellani, M.D. (visitor), Dr. A. P. Young, Miss Carson, Dr. Louis W. Sambon (visitor), and the President.

In the absence of the author, Dr. Gilchrist's paper on *Jasus lalandii* (Milne Edwards) was epitomised by the Rev. T. R. R. Stebbing, with occasional comments.

A paper by Mr. B. Millard Griffiths, M.Sc., communicated by Prof. G. S. West, F.L.S., was briefly explained by the Botanical Secretary, its title being "The August Heleoplankton of some North Worcestershire Pools."

Dr. Stapf spoke on the distribution of the Box, *Buxus sempervirens*, Linn., and especially on the relation existing between the English stations and its area on the Continent, supporting his remarks by lantern-slides (distribution-map and views of Box on Boxhill and in the Chilterns, the latter taken by Mr. John Hutchinson). He pointed out that he adopted Dr. Christ's views as to the character of the Box as a relict of the Tertiary flora of Southern Europe, and the discontinuous distribution as brought about by disintegration of an old continuous and much larger area. But he could not share his view that the isolated stations in Western France are generally due to old plantations around castles and monasteries. He considered them like the English stations as relict stations. He finally expressed a wish that these should be more thoroughly studied than has been hitherto, and carefully preserved as far as possible.

The discussion which followed was engaged in by Dr. A. P. Young, Mr. T. A. Sprague, Mr. F. N. Williams, Mr. J. C. Shenstone, Mr. T. A. Dymes, and Mr. C. E. Salmon, Dr. Stapf replying.

March 16th, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 2nd March, 1916, were read and confirmed.

Mr. Wilfrid Omer Cooper, and Colonel Herbert Edward Rawson, C.B., R.E., were elected Fellows, and Mr. George Edward Massee, an Associate.

The General Secretary drew attention to two 16th Century volumes recently presented to the Library by Sir Frank Crisp, Bt., and a special vote of thanks was accorded to the donor.

The President exhibited a series of coloured lantern-slides showing the "Resemblance between African Butterflies of the genus *Charaxes*; a new form of Mimicry."

Mr. C. C. Lacaita read a paper entitled, "Plants collected in Sikkim, including the Kalimpong District, April 8th to May 9th, 1913." He gave an account of his circular journey from Darjiling to his starting-point, part of it with the party of H.E. the Governor of Bengal. The monotony of the forest region was mentioned, and the marvellous abundance of the Aroids. An account of a new *Rhododendron* and some critical remarks on the species of *Fragaria* ended the introduction, and some lantern-slides of the scenery and people closed the paper.

Mr. E. P. Stebbing exhibited a series of lantern-slides showing aspects of forestry at home and abroad, and urged the extreme importance of planting and the abundant scope for it in many districts in the United Kingdom.

April 6th, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 16th March, 1916, were read and confirmed.

Colonel Herbert Edward Rawson, C.B., R.E., and Mr. Wilfrid Omer Cooper were admitted Fellows.

Dr. James Charles McWalter was elected a Fellow.

Dr. Annie Porter, F.L.S., and Dr. H. B. Fantham, M.A., F.Z.S., exhibited microscopic preparations of Spirochætes and of *Blastocystis* found in the stools of soldiers suffering from dysentery.

The Spirochætes were small sinuous organisms, showing a diffuse nucleus of chromatin granules. Their ends were pointed. Some were broader than others and they measured up to 15 μ in length, the variation being due to growth and division. The exact relation of these Spirochætes to dysentery is still under investigation, but spirochætal dysentery has been recorded by earlier workers.

Some stages of the development of *Blastocystis hominis* also were shown. These parasites are spherical and possess cytoplasm with one or more nuclei usually at the periphery. The organisms are probably non-pathogenic. They may present a superficial resemblance to cysts of dysenteric Amœbæ, and were once thought to be cysts of *Trichomonas*. *Blastocystis* is probably more nearly related to the Ascomycetes.

A paper entitled "A description of five new Species of *Edwardsia*, Quatr., from New Guinea, with an account of the order of succession of the micromesenteries and tentacles in the Edwardsidæ," by Prof. Gilbert C. Bourne, M.A., D.Sc., F.R.S., F.L.S., in the absence of the author on service, was read in title.

Prof. W. J. Dakin, D.Sc., F.L.S., submitted his paper, "A new species of Enteropneusta, from the Abrolhos Islands," which also was read in title.

Dr. O. Stapf, F.R.S., Sec.L.S., showed a series of maps and lantern-slides explaining the presence of the southern elements of the British flora. He referred to H. C. Watson's terms "British, English, Atlantic, Germanic," etc., proposed in 1835, and employed in his 'Cybele' in 1847; the term "Atlantic," defined by him "as having reference only to distribution within Britain," was unfortunate as confining the conception to the British flora as a detached item from the Continental flora. The year before the first volume of Watson's 'Cybele' appeared, Edward Forbes issued his remarkable address on types of distribution, undoubtedly inspired by Watson's preliminary essay, but he had a wider grasp of the subject, and basing his remarks upon geological causes, divided the native plants into five groups. The group least represented occurs in the mountains of the west and south-west of Ireland, allied to species found in the north of Spain; he specified twelve, but reduced to the modern concept of species, they are the following nine:—*Saxifraga Geum*, *S. umbrosa*, *S. hypnoides*, *Erica Mackaiana*, *E. mediterranea*, *Daboëcia polifolia*, *Arbutus Unedo*, *Pinguicula grandiflora*, and *Arabis ciliata*. He further referred to others found in the Channel

Islands. The first group he termed "Asturian," the second "Gallican" types. He showed that the derivation was due to a former land-connection, unsubmerged during the Glacial Epoch. Engler held that the reimmigration of the Atlantic element took place in post-glacial times, and Dr. Scharff dealt incidentally with it in his chapter on the Lusitanian fauna published in 1899. The subject assumed greater prominence at the British Association Meeting at Portsmouth in 1914, when Mr. Clement Reid gave an address on the relation of the present plant population of the British Isles to the Glacial Period, and contended that no temperate flora could have survived the rigours of that time, but that the present flora came in towards the end of that period.

Dr. Stapf showed that two classes of plants became evident as the work went on; one, such as had their Continental areas in Western France and the Iberian Peninsula, and the other, those ranging beyond these limits over North Africa, and the Mediterranean as far as the Caucasus and Syria. The first may be called "Atlantic" in a restricted sense, the second "Mediterranean," both together as "Southern." The complete list was drawn up by comparing the last editions of Babington's 'Manual' with Koch's 'Synopsis,' with a few necessary restrictions, but excluding *Hieracium*, *Rubus*, and *Rosa*. In this way 1500 species remained, of which 150 answered to the definition of Southern elements, or about 10 per cent. These were traced in their distribution, and the result recorded in the maps shown. The littoral species, amounting to fully one-third of the Southern elements, must affect the cartographic result; the inland or non-littoral Southern species of the British flora number 95, one-half following the Atlantic, and the other half the Mediterranean type of distribution.

Mr. J. C. Shenstone, Prof. G. S. Boulger, Mr. John Hopkinson, and Dr. C. E. Moss discussed various points raised, and Dr. Stapf replied.

May 4th, 1916.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 6th April, 1916, were read and confirmed.

Mr. Gervaise Turnbull was admitted a Fellow.

Mr. Thomas William Brown and Dr. William Thomas Elliott, F.Z.S., were proposed as Fellows.

Prof. Henri Lecomte, Prof. Edmond Perrier, and Prof. Pier' Andrea Saccardo, were elected Foreign Members.

The following were nominated as Auditors for the Treasurer's Accounts to the 29th April, and were elected by show of hands:—

For the Council: Mr. James Groves and Dr. A. B. Rendle;
For the Fellows: Mr. John Hopkinson and Mr. Leslie B. Hall.

The first paper was by Mr. E. A. Bunyard, F.L.S., on "The Origin of the Garden Red Currant."

The author stated that until recently the Red Currant was regarded as descended from *R. rubrum*. Ed. Janczewski, however, showed in 1907 that *R. vulgare* of Lamarck was the species chiefly concerned, and in his collection of garden varieties 44 were derived from *R. vulgare*, 1 from *R. petræum*, and 4 from *R. rubrum*. Three of these last were unnamed varieties from Lithuanian gardens. The writer has collected 70 varieties from Europe and America, and considers Janczewski has under-valued the importance of *R. rubrum*. The influence of *R. petræum* can also be traced in many varieties. The Red Currant has been cultivated from the early 15th century, and was at first pure *R. vulgare*; for 100 years no variations were recorded. *R. petræum* was introduced into gardens in 1561 by Konrad Gesner, and a few years after Camerarius mentions the "old" red and a new variety "baccis rubris majoribus."

R. rubrum seems to have come into Currant history at a later date. A large fruited variety, called by Janczewski *R. vulgare macrocarpum*, was introduced in 1840, and is considered by him a mutation or giant form of *R. vulgare*. The origin of this variety is uncertain, but neither in size of fruit nor in other characters does it exceed forms of *R. petræum* which have been found wild.

The author considers that inter-hybridisation of the three species—*R. vulgare*, *R. rubrum*, and *R. petræum*—is sufficient to account for the numerous varieties of the Red Currant as grown in gardens of to-day, and the supposed effects of cultivation need not in this case be invoked.

Mr. F. N. Williams, F.L.S., from his own recent study of the British forms, supported Mr. Bunyard's conclusions.

Dr. J. C. Willis, F.L.S., then introduced the subject of the Dispersal of Organisms, as illustrated by the floras of Ceylon and New Zealand.

He stated that in two recent papers on the flora of Ceylon, and in a forthcoming one on the flora of New Zealand, he had brought forward conclusions on geographical distribution which, if accepted, will remove that subject from the immediate realm of evolution, and show that it may be largely studied by arithmetical methods. Once a species is evolved, its distribution depends upon causes which act mechanically. As all families and genera behave alike, it seems to him that one cause only must be responsible for their

behaviour, but a combination of causes may be acting, though in that case each cause must act mechanically on all alike.

The cause which seems the determining factor in dispersal is *age* within the country concerned. This opinion was based upon the results of his work on the Ceylon flora, which showed that the endemic species (presumably the youngest) occupied much the smallest areas, those common to Ceylon and South India (next youngest) areas considerably larger, and those of wider dispersal than this (the oldest) are as yet larger again, while at the same time each group showed a graduated series of plants occupying each size of area, the endemics varying down the scale from 90 to 233, the "wides" up from 144 to 462.

Not only do the grand totals show this distribution according to age, but also family by family, and genus by genus (of reasonable size) do so. The rarity of all the endemics (in figures from 1 to 6) is 4·3, and when taken in groups of not fewer than 14 it only varies from 3·9 to 4·9, while that of the other two groups varies similarly about 3·5 and 3·0.

Some having objected that Ceylon is a special case, he obtained confirmation of his views by working out the flora of New Zealand. To test his hypothesis, he wrote the paper first predicting what, under that hypothesis, must be expected, and as all his predictions were confirmed by the facts, the result has given him considerable confidence in the truth of the hypothesis.

One does not often come across cases like Ceylon, where the local species can be divided into groups according to age, and confirmation of his hypothesis must rest on finding cases to parallel one or more of the features which showed so conspicuously in the Ceylon flora. New Zealand parallels it in several respects, and other cases are quoted in which similar parallelism is exhibited.

Some of the objections to these views have been considered, *e. g.* the hackneyed argument that introduced species spread rapidly over islands at the expense of the indigenous flora; this is shown by the cases of Ceylon and Rio de Janeiro to be an unsound position. The objection that the endemic species are the oldest in a country is also dealt with, likewise that which asks why one does not see the spreading going on, if it depend upon age.

A discussion followed, Dr. A. B. Rendle, Dr. D. H. Scott, Dr. O. Stapf, and the President taking part, the author replying.

The following papers were, in the absence of their authors, read in title:—

Mr. R. J. Tillyard, M.A., B.Sc., F.L.S.—A Study of the Rectal Breathing Apparatus in the Larvæ of Anisopterid Dragonflies.

Mr. Walter E. Collinge, M.Sc., F.L.S.—Description of a new species of *Idotea* (Isopoda) from the Sea of Marmora.

Amongst the specimens collected by the 'Thor' on the Danish Oceanographical Expeditions 1908–1910 to the Mediterranean and adjacent seas, were a large number referred by Dr. K. Stephensen to *Idotea metallica*, Bosc. Further examination, however, showed that only a very few of the specimens were referable to that species, the remainder belonging to a new species which is now described; it differs from *I. metallica* in its more elongated form, parallel sides, triangular and well-developed coxal plates of the mesosome, and in a number of other important structural details.

May 24th, 1916.

Anniversary Meeting.

Prof. E. B. Poulton, F.R.S., President, in the Chair.

The Minutes of the General Meeting of the 4th May, 1916, were read and confirmed.

Mr. William Williamson, F.R.S.E., was proposed as a Fellow.

The Treasurer submitted the Annual Statement of Accounts duly audited, and explained a few points of interest; on the motion of the President the Statement was received and adopted. (See pp. 18–20.)

The General Secretary laid his report of deaths, withdrawals, and elections before the Meeting as follows:—

Since the last Anniversary the deaths of 16 Fellows have occurred or have been ascertained, namely:—

Reginald Gervase Alexander, J.P., M.A., M.D., D.Sc.
Richard Assheton, M.A., Sc.D., F.R.S.
Frederick Manson Bailey, C.M.G.
Richard Manliffe Barrington, M.A., LL.B.
Henry Charlton Bastian, M.A., M.D., F.R.S.
Henry Eeles Dresser, F.Z.S.
David Thomas Gwynne-Vaughan, M.A.
Francis Elliott Kitchener, M.A., LL.M.
Ernest Lee, A.R.C.S.
Robert Heath Lock, M.A., Sc.D.
James J. MacAndrew.
Edward Alfred Minchin, M.A., Ph.D., F.R.S.
Madabusi Srinivasa Ramaswami, M.A., B.A.
Charles Loxton Rothwell-Jackson, F.R.M.S., M.Inst.C.E.
Henry Spicer, B.A., F.G.S.
William Booth Waterfall.

Also 2 Foreign Members.

Charles René Zeiller.
Hermann, Graf zu Solms-Laubach.

And 1 Associate.

John Medley Wood, D.Sc.

11 Fellows have withdrawn, namely:—

William Thomas Calman, D.Sc.
William Dennis, F.C.S.
Ralph Evelyn Drake-Brockman, M.R.C.S., L.R.C.P.
William Fawcett.
Samuel Gasking, B.A., LL.D.
William Moyle Rogers.
Francis Henry Sikes, M.A.
Thomas Southwell, A.R.C.S.
James Stuart Thomson, Ph.D.
Henry William Marett Tims, B.A., M.D.
Grace Wigglesworth, M.Sc.

4 removed from List, in accordance with the Bye-Laws, Chap. II. § 6.

William Clitheroe.
Frederick Enock.
David Hooper, LL.D.
August Wilhelm Kappel.

16 Fellows have been elected, of whom 15 have qualified up to the present; also 3 Foreign Members and 1 Associate.

The Librarian's Report was submitted as follows:—

During the year there have been received as donations from private individuals and the editors and proprietors of independent journals, 127 volumes and 374 pamphlets and parts.

From the various Universities, Academies, and Scientific Societies, with which the Society is in correspondence, there have been received in exchange 236 volumes and 328 detached parts.

The Council, at the recommendation of the Library Committee, have sanctioned the purchase of 112 volumes and 126 parts of important works.

The total additions to the Library are therefore 475 volumes and 828 pamphlets and separate parts.

The number of books bound during the year was 213, of which 3 were in whole morocco, 79 in half-morocco, 11 in buckram, 95 in cloth, and 25 re-labelled.

The General Secretary having read the Bye-Laws governing the elections, the President opened the business of the day, and the Fellows present proceeded to vote for the Council and Officers.

The Ballot for the Council having been closed, the President appointed Mr. C. Sillem, Mr. W. Barratt, and Mr. T. A. Dymes, Scrutineers; these having examined the Ballot-papers and cast up the Votes, reported to the President, who declared the result as follows:—

Mrs. Arber, D.Sc.; Prof. W. Bateson, F.R.S.; L. A. Boodle, Esq.; E. T. Browne, M.A.; R. H. Burne, Esq.; A. D. Cotton, Esq.; E. S. Goodrich, F.R.S.; James Groves, Esq.; Dr. B. Daydon Jackson; Miss G. Lister; Gerald Loder, M.A.; Horace W. Monckton, F.G.S.; Dr. C. E. Moss; Prof. G. E. Nicholls; Prof. E. B. Poulton, F.R.S.; Sir David Prain, C.M.G., F.R.S.; Dr. A. B. Rendle, F.R.S.; Dr. A. E. Shipley, F.R.S.; Dr. Otto Stapf, F.R.S.; and Comr. J. J. Walker, R.N.

The retiring Councillors were, Dr. W. T. Calman (withdrawn), Sir Frank Crisp, Bt., Prof. W. A. Herdman, F.R.S., Hugh Scott, M.A., and Prof. A. C. Seward, F.R.S.

The Ballot for the Officers having been closed, the President appointed the same Scrutineers, and these having examined the Ballot-papers and cast up the Votes, reported to the President, who declared the result as follows:—

President: Sir David Prain, C.M.G., F.R.S.

Treasurer: Horace W. Monckton, F.G.S.

Secretaries: Dr. B. Daydon Jackson.
E. S. Goodrich, F.R.S.
Dr. A. B. Rendle, F.R.S.

The Rev. James Marchant, on behalf of the 'Alfred Russel Wallace Memorial Fund,' presented a bronze cast from the original model by Mr. Albert Bruce-Joy for the Medallion recently unveiled in Westminster Abbey to the memory of the late Naturalist, together with a copy of his memoir of Dr. Wallace, inscribed with the name of the Linnean Society.

A special vote of thanks was passed to the Committee of the Fund for these most acceptable gifts.

The President then delivered his Address, "The Hereditary Transmission of Small Variations and the Origin of Butterfly Mimicry," which was illustrated by specimens and lantern-slides.

Treasurer's Accounts for the Year ended April 29th, 1916.

(Presented at the Anniversary Meeting, May 24th, 1916.)

Receipts and Payments of the Linnean Society from May 1st, 1915, to April 29th, 1916.

General Account.

Receipts.	£	s.	d.
Balance at Bankers on 1st May, 1915	90	19	9
Interest on Investments	238	15	5
Admission Fees	90	0	0
Annual Contributions	1533	0	0
Sales of Publications:—			
Transactions £73 9 4			
Journals 105 0 8			
Proceedings and Catalogues 3 2 6			
	181	12	6
Sir Frank Crisp, Bt., Donation in aid of Shelving	17	10	0
Fellows' postal account, deposits	10	16	0
Donations in aid of Publications	436	17	9
Miscellaneous Receipts	18	7	6
	£2617	18	11

Payments.	£	s.	d.
Taxes and Insurance	24	7	9
Repairs and Furniture	43	16	6
Coal, Electric Current, and Gas	54	18	4
Salaries	725	16	4
Library:—			
Books £92 7 8			
Binding 79 3 2			
	171	10	10
Expenses of Publications:—			
Printing £568 19 0			
Illustrations 265 5 9			
Distribution 42 16 3			
	877	1	0
Miscellaneous Printing and Stationery	112	1	1
Petty Expenses (including Tea and Postage) £83 7 5			
Fellows' postal account 5 8 9			
	88	16	2
Linnean Medal	15	0	0
Balance at Bankers, 29th April, 1916 (including £68 19 10, deposits, Fellows' postal account) £460 12 0			
Cash in hand { 39 2 0 / 4 16 11			
	504	10	11
	£2617	18	11

Separate Account.

		£	s.	d.
To Balance at Bankers, 1st May, 1915 :—				
Westwood Fund	£14 17 8			
Trail Award Fund	18 1 0			
Crisp Award Fund	18 17 8			
Hooker Lecture Fund	17 0 10			
Tagart Fund	17 5 4			
		86	2	6
„ Interest on Investments:—				
Westwood Fund	£6 10 3			
Trail Award Fund	3 10 0			
Crisp Award Fund	5 18 0			
Tagart Fund	17 6 3			
Hooker Lecture Fund	11 1 4			
		44	5	10
		£130	8	4

		£	s.	d.
By Grant from Westwood Fund for illustrations in R. J. Tillyard's paper	£10 7 9			
„ Purchase of Books (Tagart Fund)	18 14 5			
„ Award and Bronze Medal to Dr. Leonard Doncaster (Trail Award Fund).	16 5 0			
		45	7	2
„ Balance at Bankers, 29th April, 1916 :—				
Westwood Fund	£11 0 2			
Trail Award Fund	5 6 0			
Crisp Award Fund	24 15 8			
Hooker Lecture Fund	28 2 2			
Tagart Fund	15 17 2			
		85	1	2
		£130	8	4

Investments on April 29th, 1916.

General Account.

£	s.	d.	
1150	0	0	Metropolitan Consolidated 3½ per cent. Stock.
42	1	5	Great Indian Peninsula Railway, Annuity Class B.
450	0	0	Forth Bridge Railway 4 per cent. Stock.
1000	0	0	Metropolitan Consolidated 3 per cent. Stock.
1290	0	0	India 3 per cent Stock.
1000	0	0	Eastern Bengal Railway 4 per cent. Debenture Stock.
1000	0	0	Great Western Railway 4 per cent. Debenture Stock.
300	0	0	Midland Railway 2½ per cent. Preference Stock.

Separate Account: *Investments on April 29th*, 1916.

£	s.	d.	
232	5	0	Metropolitan Water Board 3 per cent. "B" Stock (Westwood Fund).
393	3	5	Ditto ditto (Hooker Lecture Fund).
100	0	0	New South Wales 3½ per cent. Stock (Trail Award Fund).
252	18	0	2½ per cent. Consolidated Stock (Crisp Award Fund).
530	0	0	East Indian Railway 3½ per cent. Debenture Stock (Tagart Fund).

HORACE W. MONCKTON, *Treasurer*.

We have (in conjunction with the Professional Auditor, who certifies as to all details) audited the Accounts of the Society for the year ended 29th April, 1916, and found them correct. We have verified the Investments and Bank Balances.

Dated this 18th May, 1916.

W. B. KEEN, *Chartered Accountant*.

A. B. RENDLE,
JAMES GROVES,
L. B. HALL,
JOHN HOPKINSON,
B. DAYDON JACKSON,
} *Auditors*.

PRESIDENTIAL ADDRESS, 1916.

The Hereditary Transmission of Small Variations and the Origin of Butterfly Mimicry.

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A. Introduction.

New and illuminating ideas not only displace much that is erroneous, they unfortunately also tend to disturb much that is true. One old-established truth, as it has been held to be and as I hope to show it to be, forms the subject of the present address.

The evidence for the hereditary transmission of small variations which I propose to lay before you has been yielded by the Lepidoptera, and nearly all of it by butterflies. The special value of the Lepidoptera in the study of variation was strongly insisted upon by A. R. Wallace in his great memoir * read before the Linnean Society on March 17, 1864. The strength and amount of the evidence might, I believe, be indefinitely increased but for the fact that breeders have been led to select the larger rather than the smaller differences as the more conclusive illustration of Mendelian theory, or, from a very different but insistent motive, as more successful in filling their cabinets with striking specimens. But I hope to show that a considerable body of evidence exists, and it is only necessary to direct attention to the fundamental importance of the enquiry to ensure that searching tests will be applied in many directions.

It is to be observed that I am not dealing on the present occasion with heredity as Mendelian or non-Mendelian. I am concerned to prove that small variations are inherited, whatever be the laws that govern their inheritance. I am indeed disposed to think that this address would have been superfluous if serious attempts had been made, with the right material, to answer the question—'what are the smallest variations subject to Mendelian heredity?' One example to be described in later pages (see pp. 25, 26) seems sufficient to prove that they may be very small.

In speaking of Mendelian heredity, I take this opportunity of calling attention to the fact that, shortly before his death, the late G. J. Romanes independently discovered the reappearance of

* *Transactions*, vol. xxv., 1866, p. 1. See especially p. 22 and the following passage on pp. 1–2:—"This delicately painted surface [of the wings] acts as a register of the minutest differences of organization,—a shade of colour, an additional streak or spot, a slight modification of outline continually recurring with the greatest regularity and fixity, while the body and all its other members exhibit no appreciable change. The wings of Butterflies, as Mr. Bates has well put it, 'serve as a tablet on which Nature writes the story of the modifications of species.'" See also the present writer's "Essays on Evolution," Oxford, 1908, pp. 50–54, and the references there given.

the parental forms of hybrids, in the F_1 generation. I well remember his telling me of the contrast between the uniformity of the hybrids and the sharp division of their offspring into the two parental types *.

B. Indirect and Direct Evidence of the Hereditary Transmission of Small Variations.

a. *Persistent Variation in two Colonies of a Zygænid Moth on E. Dartmoor.*—This interesting example was observed and recorded † by Dr. R. C. L. Perkins. The colonies of *Anthrocera* (*Zygæna*) *trifolii*, which had been observed in four out of the five years ending in 1914, occupied two points on the margin of a pond about 1000 ft. above sea-level. They were separated in the direct line by about 200 yards of water, and the intervening ground along the margin was untenable by the species. Each colony occupied about 15 square yards of boggy ground covered with rushes, in one case intermixed with *Sphagnum* moss. Up to 1914 the colonies were so weak that no specimens were collected, although a difference in variation was noted. In 1914, however, each colony was estimated, from the number of the cocoons which were prominent well up on the rushes, to contain about 100 individuals. The moths from the area with *Sphagnum* are larger, with the red spots on the fore wing distinct or at most the two middle ones confluent. The specimens from the other area are generally of small size, and most of them have "either the three apical spots connected or all are confluent, or the three basal ones. In some the basal part of the hind-wings is yellowish in daylight." The moths are sluggish and are well known to cling year after year to the same small area.

In this example the hereditary transmission of local variation can hardly be doubted; for the *Sphagnum*, not the food-plant of the species, is scarcely likely to be called on as a *Deus ex machinâ*.

* This was the subject of his exhibit at the Royal Society Soirée on June 15, 1892. The following account, printed in the programme, does not explain the mode of breeding by which he obtained the results described. It is nevertheless implied in these results, and as I have stated he told me of it.

18. *Exhibited by Mr. G. J. Romanes, F.R.S.*

Living Rats and Rabbits, showing some results of experimental breeding with reference to theories of heredity.

The experiments prove the error of those writers who assume that an act of fertilization consists in the male and female elements intimately blending together, after the manner of a merely mechanical mixture, so that the offspring always presents characters more or less intermediate between those of its parents. In many cases this does happen, but in many other cases the admixture of hereditary elements is by no means intimate—those derived from the father and mother appearing to remain respectively grouped together, with the results shown in the exhibit.

† *Proc. Ent. Soc. Lond.*, 1914, pp. xcv, xcvi. The specimens referred to may be studied in the Hope Department, Oxford University Museum.

The objection may be raised that the variation is large and not small—a matter of opinion which might be discussed indefinitely. It is sufficient for the present purpose to say that the fusion of certain spots in a pattern, or a slight change of tint over part of the surface of a wing are good examples of the kind of variation by which mimetic resemblance has been, in my opinion, perfected.

b. *Hereditary Transmission of Small Variations in the British Moth* Spilosoma mendica.—I owe the two following examples of the hereditary transmission of a very small variation to Mr. A. Bacot, who has kindly presented the material, exhibited to the meeting, to the Hope Department, where it can be studied at any time. Concerning *S. mendica* Mr. Bacot wrote:—"I captured, at Chigwell in 1890, a female specimen of *Spilosoma mendica* which had a small duplication of two of the black dots situated near the hind margin of the fore wings on the upper surface, and also a small spot within the cell near the base of the fore wing. From ova laid by this moth I reared 8 males and 8 females. One male shows the two additional spots near the margin of the wing and also the basal spot; a second male shows, of these markings, only one additional marginal spot, a third male only the basal spot." Nearly all these markings are smaller than in the parent, but all can be distinctly made out with a lens.

c. *Hereditary Transmission of Small Variations in the European Moth* Syntomis phegea.—The second example, referred to by Mr. Bacot in the following paragraph, is even more striking:—

"In a brood of *Syntomis phegea* * that I passed on to you there was an example that had a small but very distinct addition to one of the transparent spots (I think on one side only). I bred from this example, and some of the specimens in the resultant brood showed a similar alteration in the spot. I think that you will have no difficulty in finding the point if you refer to the brood."

The material of the experiment was derived from two males and two females bred in 1899 from Swiss larvæ. From a pair of these was reared in 1900 a family of 17 males and 23 females. The central spot of the fore wing,—the only one in the cell—which exhibited slight variability in the four 1899 specimens, shows a much wider range in the 1900 family. The differences in size are very marked, in fact in one of the females the spots are evanescent. Even more striking is the extent of the unilateral variations, reaching its climax in one male with a semicircular invasion of the black ground-colour obliterating about a quarter of the left-hand spot, while the right one retains the normal size and unbroken squarish outline. Considerable but less marked variations of the same kind are present on the left

* Exhibited, except the 1902 family, by Mr. Bacot at the City of London Entomological and Natural History Society, Feb. 19, 1901. *Transactions*, 1901, pt. xi. pp. 8, 23 (Title only).

side of two and the right side of four females, and in a smaller degree in other males and females. In one male with all the spots small, that in the left fore-wing cell is barely visible, although the right is the largest spot in the entire pattern of the specimen.

Mr. Bacot bred from the male first described and a female which is either lost or at any rate cannot now be identified with certainty. From these parents he reared in 1901 a family of 8 males and 5 females. In three males the spot is large and normal on both sides, in one it is very small on the right, in one very small and divided into two on both sides. The left spots of the remaining three males resemble the male parent in varying degrees: in one it bears a minute central dark spot, in one (A) it resembles the male parent but with a rather smaller invasion, in the third the invasion is much larger leaving only a triangular remnant and a minute dot. The right-hand spots of these three are normal, resembling that of the male parent. The left-hand spot of a single female (B) resembles that of the male parent, the other four being normal or with a slight trace of asymmetry.

Mr. Bacot bred from A and B, rearing in the 1902 family 4 males and 5 females. Of the males, two have much smaller spots on the left, one of them being divided into two; the other two males show only slight asymmetry. Of the females, three show the parental character but in an exaggerated form, the invasion having been carried further, and starting in one of them from the basal margin of the spot instead of its outer margin, as in the others and the parents. A fourth female resembles that last described, except that the invasion is into the right spot instead of the left and has been carried further so that two small dots representing the two outer angles of the spot are all that remain. The fifth female is normal with little want of symmetry.

No one who looks at the material can doubt that this small but striking variation, affecting the shape of a single spot, is hereditary. The series also affords evidence of another kind in favour of the view suggested on p. 22, that Mendelian inheritance will be found to hold in extremely small variations, as well as in large ones. The hind wing in the female *S. phegea* bears two large patches, of which the outer is generally accompanied by a small detached spot lying on its upper (or costal) border. In the male both patches are reduced to spots of which the inner one is especially small and in most individuals represented only by its upper (or costal) section, the lower section when present being minute and quite detached. The evidence bearing on Mendelian inheritance is derived from the presence or absence of the small inner spot in the male hind wing.

Of the two 1899 males, one is normal while the other is as last described, the lower section of the inner spot being much smaller and barely visible on the right side.

In the 1900 family six males are normal, in three or four more

the inner spot (upper part only) can be detected with a lens, but in the rest it is altogether absent. There is the most gradual transition from the male in which the inner spot is largest to the one in which it is smallest and can barely be made out with a good lens. The male parent (A) of the 1901 family is without the spot.

Seven males of the 1901 family are normal, while the eighth possesses, in addition to the upper, a distinct lower section. Although the inner spots are transitional in size from normal to very small, none are so minute as to require the use of the lens. The facts strongly suggest that the presence of the inner spot is dominant and that the female parent (B) carried the factors of the normal male. This interpretation is rendered almost certain by the four males of the 1902 family, of which two are without the spot and two with it. Of the latter, one is normal while the other has the lower section as well as the upper, this lower section being in fact better developed than in any other male in the whole of Mr. Bacot's material.

C. Geographical Races or Subspecies.

A large amount of excellent work for many years has been devoted to the study of the differences by which a species is split up into races in various parts of its total geographical range. In Lepidoptera these differences are sometimes large, sometimes so small as to rest upon a slight change in the form or size of a single marking or even the presence of a few coloured scales requiring a lens for their detection. It has recently been argued that geographical races when based on small differences are due to some influence resident in the locality—acquired and not hereditary. Thus Professor Punnett has suggested * that this may be the interpretation of a certain small difference between the Oriental and African forms of *Danaida chrysippus*. During the past few years I have endeavoured to persuade naturalists to breed this butterfly and test whether a high or low degree of development of the character in question—a single spot in the fore wing—is hereditary, and whether the local races will still come true if bred in another country inhabited by another local race of the same species. Up to the present I have not succeeded. The butterfly is so very common that it is difficult to arouse sufficient interest in it. Furthermore it is not always easy to find naturalists who can breed butterflies successfully. But evidence of another kind, yielded by the allied American *Danaida plexippus* (*archippus*), seems to me quite conclusive. Availing itself of modern means of locomotion, the North American race of this butterfly (other races of the same species exist in Central and South America) has during the past 70–80 years been gradually extending its range over the warmer parts of the world. Fortunately

* "Mimicry in Butterflies," Cambridge, 1915, pp. 132–134. See also *Bedrock*, Oct. 1913, pp. 300–301; Apr. 1914, pp. 41–43.

it has found its historian in Commander J. J. Walker *, who has recorded its westward migration from 1840 (New Zealand) to 1889 (Straits of Malacca), and eastward from 1863 (Azores) to 1897 (Grecian Archipelago). In many of the localities it has established itself for numbers of years and appears to be now a permanent resident. In spite of all the varying local influences to which it has been subject in its numerous scattered colonies, Commander Walker has never seen a record of any form except the North American one.

It is unnecessary however to rely solely on experiments made, partly by man who has accidentally transported species to distant lands, partly by nature which has then subjected them to all the strange conditions of the new home. We can appeal to instances in which the whole process has been natural—to local races distinguished by small differences. If now these races, bred in a strange locality, preserve their original differences, the desired test is forthcoming.

I. Direct Evidence of Hereditary Transmission of Local Difference.

a. *Local European and British Races of the Butterfly* Pieris napi *bred in the London District.*—This butterfly, the common English "Green-veined White," has been long known to form local races in various parts of its range. Many of these have been described and named in works on European butterflies. The differences are mainly exhibited by the females but are sometimes fairly well-marked in the males as well. This species has been extensively bred from the egg or from very young larvæ which hatched in transit, by Mr. Hugh Main and the late Mr. Albert Harrison. All the broods were reared at South Woodford, N.E. Mr. Main has kindly drawn up a brief account of the work:—

"Being interested in the local forms, etc., of *Pieris napi*, the late Mr. Albert Harrison and I reared large numbers of this

* Commander Walker's papers and notes on this species have all appeared in *The Entomologist's Monthly Magazine*, and are as follows:—

(1) "*Anosia plexippus*, L. (*Danais archippus*, F.): A Study in Geographical Distribution." (1886, xxii. 217–224.)

(2) "*Anosia plexippus*, L. (*Danais archippus*, F.) at Gibraltar." (1886, xxiii. 162.)

(3) Observations on the occurrence of "*Danais plexippus*" at Damma, Amboyna, and Ternate. (1893, xxix. 25, 27, 30.)

(4) Observations on occurrence of "*Anosia plexippus*" in New Caledonia, the New Hebrides and the Loyalty Islands. (1902, xxxviii. 192 *et seqq.*)

(5) Observations on occurrence of "*Anosia plexippus*" at Sydney, N.S.W. (1905, xli. 220.)

(6) "The Geographical Distribution of *Danaida plexippus*, L. (*Danais archippus*, F.) with especial reference to its recent migrations." (1914, l. 181–193, 224–237.)

(7) "Some more British records of *Danaida plexippus*." (1914, l. 290.)

(8) "A note on the distribution of *Danaida plexippus* in Australia." (1916, li. 294.)

For a brief abstract of the results see *Bedrock*, Apr. 1914, pp. 41, 42.

variable insect. Through the kindness of a number of entomological friends we received either living females or freshly deposited ova from a number of different localities in England, Scotland and Ireland, and also from different parts of Switzerland, and from Lapland. From Lapland the female parents were all of the dark var. *bryoniæ*, and we had females of this var. and of the type from different localities in Switzerland.

"In some cases the broods were carried on for two or three years, those from each locality being kept distinct. We always found that each family, though usually exhibiting the wider variability of the species, retained the original general character of the first parents: *e. g.*, the broods from Lapland had a close resemblance to each other, and were very distinct from all the broods from the var. *bryoniæ* females from Switzerland.

"The Lapland specimens resulted from ova despatched by Mr. W. G. Sheldon as soon as they were deposited. The ova generally hatched before arriving in England.

"At Glarus, Switzerland, Dr. T. A. Chapman captured at the same altitude females of var. *bryoniæ* and of the type, which he sent alive. Ova were obtained from several of each, and the progeny of the two forms entirely resembled the parents. All the females resulting from the var. *bryoniæ* ova were of this form, while no *bryoniæ* were produced from ova laid by typical females. The males of both forms I am unable to distinguish from one another. The progeny of the typical females were double-brooded, but only in one family of *bryoniæ* did we obtain any of the summer brood, three females being produced. All the rest of the *bryoniæ* pupæ lay over the winter.

"It is difficult to describe the differences between the various local forms from the British localities, and it would be impossible to separate them accurately if the specimens were all mixed up, but in long series it is seen that there is a strong tendency towards certain extremes which occur in the different places. These strong tendencies are equally evident in the specimens bred from ova deposited in Woodford by females sent from various localities in England, Scotland and Ireland."

The bred and captured specimens kindly lent by Mr. Main, Mr. H. J. Turner and Mr. W. G. Sheldon in illustration of this address entirely bear out the above statements. I especially wish to direct attention to the difference between the Lapland *bryoniæ*, both captured and London bred, and the Swiss *bryoniæ*, both captured and London bred. The two Lapland families and the captured female are smaller and greyer than the commonest Swiss form,—their yellow tint paler and duller, their fore-wing spots smaller and less dark. The close resemblance between 40 *bryoniæ* bred in the London district and their female parent captured in Switzerland is also very striking. Still stronger evidence is afforded by the females of local races from the British Islands, particularly by the specimens bred in London from Irish (Enniskillen) parents. These exhibit the strong black markings and

black apex of the fore wing which are characteristic of their locality, most of them too the very pale buff ground-colour which is common there. The London bred specimens from Fife parents afford an interesting comparison, having the markings almost equally well developed, but greyer, and the ground-colour commonly cream rather than pale buff.

In comparing the bred with the captured specimens, the former are of course fresher and the dark markings therefore clearer and sharper. Apart from this there is, Mr. Turner considers, a tendency towards an intensification of the dark markings, especially of the summer brood. Mr. W. G. Sheldon on the other hand considers that the female offspring of Lapland *bryoniæ* exhibit, when bred in England, a reduction of their characteristic features. But allowing all weight for slight effects, probably due to something unnatural in the conditions, it is quite evident that Mr. Main's conclusion is sound and entirely borne out by the extensive material kindly lent by him. Many local races of *P. rapæ* are distinguishable: these differences are hereditary and not acquired. These small variations, many of them exceedingly small, are transmitted by heredity.

b. *Local British Races of the Moth* Aplecta nebulosa *bred in the London District.*—This Noctuid moth is well known to occur in Delamere Forest, Cheshire, in three forms—(1) dark grey forms which are much the commonest; (2) a small percentage very much darker with grey fringes (var. *robsoni*); (3) a much smaller percentage quite black with white fringes (var. *thompsoni*). In breeding (1) behaves as a Mendelian dominant, (2) a heterozygote, (3) a recessive. When bred from the egg in the London district by Mr. Main and Mr. Harrison, not only did the appearance of all three forms remain unchanged, as everyone would expect, but the same was true of a pale local race found in Argyllshire. Examples of these and of the Cheshire forms have been kindly lent by Mr. Main for exhibition.

c. *Hereditary Transmission of Small Variations in W. African Butterflies of the Genus* Hypolimnas.—I here include two examples in the same genus *Hypolimnas*, both due to the careful and accurate work of Mr. W. A. Lamborn in the Lagos district of West Africa. The first is of great importance, because it not only adds to the evidence here summarised but also helps us to understand how two very different mimetic patterns arose. The West African *Hypolimnas dubia* is well known to appear in two forms—*anthedon*, mimicking the Danaine *Amauris niavius*, and *dubia*, mimicking other species of *Amauris*. Mr. Lamborn has shown that these two forms bear a Mendelian relationship to each other, *dubia* being the dominant. Intermediate patterns occur, although in very small proportions, and it might well be supposed that these are heterozygotes and that they would split up in the next generation. Twice, however, Mr. Lamborn has bred from a slightly intermediate (viz. tending slightly towards *anthedon*)

female *dubia*, and the pattern of both was strongly inherited by the *dubia* forms among the offspring *.

The second example is *Hypolimnas dinarcha*, of which Mr. Lamborn bred two large families from known female parents. In one of these the white of the hind wing is faintly tinged with yellow and there is a very slight difference in the pattern of the fore wing. There is a strong tendency towards the inheritance of both these features by the female offspring †.

d. *Hereditary Transmission of Small Variations in the* Hippocoon *Female of the African* Papilio dardanus.

The inheritance of small variations in the pattern of the black and white *hippocoon* females of *Papilio dardanus* has been carefully studied by Dr. G. D. H. Carpenter ‡, who has shown that a single small spot in the fore-wing cell differs in size in various parts of Africa and also that slight differences in this and other features between the females in the same locality are inherited by their *hippocoon* offspring. Some of these differences are excellent examples of small steps that would lead towards the transformation of the *hippocoon* pattern characteristic of one part of Africa to that which, under the influence of a slightly different model, is characteristic of another part §. Dr. Carpenter's paper is a complete answer to the contention that, in no clear case, has the inheritance of any small variation been shown to exist ‖.

II. Indirect Evidence of Hereditary Transmission of Local Difference.

a. *The V-Mark on the Hind Wing of the Danaine Genus* Tirumala.—I now propose to consider certain indirect evidence of the hereditary transmission of small variations. Of this an unlimited amount is yielded by a study of the geographical changes in the patterns of related groups of species or subspecies. In passing from one locality to another across the total range we are constantly made aware of extremely minute progressive differences only to be reasonably explained by the gradual disappearance or modification of a relatively ancestral feature highly developed or differently developed in some other part of the common area of distribution. When at some widely separated locality the progressive changes first culminate in the disappearance of the feature, this climax of modification may only be found in relatively few individuals, the others still retaining traces varying from a few scales or even a single scale up to a small but distinct representation. A little further and the proportion of entire disappearances increases while the size of the maximum representation decreases. Thus by progressive changes in the average constitution of the mass of individuals in successive

* Recorded in *Bedrock*, Apr. 1913, p. 56, plate iii.; Oct. 1913, pp. 299, 300.

† *Bedrock*, Oct. 1913, p. 300.

‡ *Trans. Ent. Soc. Lond.*, 1913, p. 656.

§ The significance of one of these hereditary features was pointed out by the present writer in *Bedrock*, Apr. 1913, p. 50.

‖ Professor Punnett in *Bedrock*, July 1913, pp. 152, 153.

geographical zones the complete disappearance of the feature may be finally reached.

The Oriental species of the Danaine genus *Tirumala* possess * a very distinct V-shaped mark at the inner end of area 2 of the hind wing, in the acute angle between vein 2 and the cell. Most of them have also a smaller mark of the same form at the inner end of area 3. One African species of the genus, *T. petiverana*, barely distinguishable from the common Oriental *T. limniace* or *T. septentrionis*, possesses the V-mark fully developed. Three other species, one of them separable into two subspecies, evidently represent a much earlier invasion, and are greatly modified—so much so indeed that Moore placed them in a separate genus, *Melinda*. I thought it would be of interest to study the fate of the V-mark in these four forms, of which two are East African and therefore near the original home, one Central, and one Western. In addition to specimens in the Oxford University Collections, I have been enabled, by the kindness of Lord Rothschild, to examine material from Tring. The result of the enquiry is shown in tabular form below.

Degrees of development of the V spot on hind wing upper side of four African forms of the Oriental Danaine genus *Tirumala*.	I. The V with the longer limb from 3·0 mm. to 3·5 mm. long.	II. V reduced to a solid arrow-head with longer side about 1·5 mm.	III. Similar to II but length 0·5–1·0 mm.	IV. A minute trace, varying downwards from a recognisable apex to a barely visible spot.	V. No trace visible, even with lens.
1. *T. formosa neumanni*, Rothsch. Abyssinia.	4 ♂ 1 ♀	2 ♂	8 ♂	3 ♂	1 ♂
2. *T. formosa formosa*, Godm. British and German East Africa.	6 ♂	9 ♂ 1 ♀	15 ♂ 3 ♀	10 ♂ 4 ♀[1]	2 ♂ 2 ♀
3. *T. mercedonia*, Karsch. Uganda.			3 ♂[2]	2 ♂[3]	39 ♂ 20 ♀
4. *T. morgeni*, Honr. Cameroons.			1 ♂[4]		1 ♂ 1 ♀

[1] The trace on L. side only of one ♂, R. only of another and of one ♀.

[2] The mark of the value of III on R. side, of IV on L. of one of the three males.

[3] The trace apparently represented by a single pale scale on L. side only of one of the two males.

[4] A very minute III. The pale tint much dimmed and not bright as in the other forms 1–3.

* *T. neptunia* of Fiji has lost this mark on the upper surface, retaining a trace below. The change is part of a general darkening in mimicry of local Euplœas.

The facts set forth in the above table are best explained by the strong endurance of a hereditary feature gradually weakened as the African invaders became further and further separated from the original stock where the feature is prominent in all the species I have examined except *T. neptunia*. I do not myself doubt that the weakening has been brought about by the selection in *mercedonia* and *moryeni* of individuals which approached most nearly to the pattern of the indigenous African Danaines of the genus *Amauris*; but from the present standpoint I am only concerned to point out that the existence side by side in the same locality of individuals with a minute trace of the mark and individuals with no trace at all, and the comparison of these with the individuals of allied forms in other localities, cannot be reasonably explained except on the supposition that the degree of development of the feature is hereditary. And the different degrees distinguished in the table on p. 31 are *very* small variations.

b. *Geographical Changes in Mimetic Species corresponding with a Change of Model.*—Under this head a large body of evidence is available in support of the conclusion that mimetic patterns arose by successive stages, and not suddenly as Professor Punnett maintains—evidence which at the same time is available for the general conclusion that small variations are hereditary. The limits of time and space prevent anything more than the discussion of one good example from Africa and another from S. America.

c. *The Mimetic Females of the African* Charaxes etheocles.—A wonderful example of geographical change in a single species is seen in the mimetic females of *Charaxes etheocles*, which in various parts of Africa mimic the females and sometimes the males of the larger species of the same genus. Among these local changes are some which are quite as small as the steps by which I believe that an elaborate mimetic pattern has been built up, and it is as certain that these small variations are hereditary as that any geographical race is permanent and fixed. It might indeed be argued by one who has not compared the specimens, that each mimetic female form in each locality had developed from the same ancestral pattern. The following examples, to which others might be added, afford evidence that the female forms are not thus evolved separately but by the modification of those in adjacent areas.

The female form *viola*, of the West Coast, possesses a broad orange bar beyond the middle of the fore wing and a still broader white one shot with blue beyond the middle of the hind wing. This form is believed by Dr. Karl Jordan to be a rough mimic of *Charaxes epijasius*. In parts of British East Africa and of Uganda the model is the male of *Charaxes ansorgei* and in correspondence with its pattern the bars of both wings are, in the form *kirki*,

more centrally placed and duller, that of the hind wing narrower. In the Taveta district of British East Africa, as was recorded by the Rev. K. St. Aubyn Rogers *, the model is *Charaxes saturnus*, and the hind-wing bar of the mimic has become clouded with orange-brown to a varying degree in different individuals, while the fore-wing bar has broadened and tends to suffuse the dark ground-colour.

d. *A South American* Heliconius *Mimetic of another Species of the same Genus.*—This example is of great interest inasmuch as it was detected in the fine and abundant material collected in Brazil between 1825 and 1830 by W. J. Burchell. Furthermore, the specimens are accompanied by statements, in the handwriting of Professor Westwood and of Burchell himself, which prove that the variation is so small that it escaped their attention altogether. The material consists of a series of dark brown nearly black butterflies, bearing on the fore wing, beyond the cell, a broad red bar, and, between the bar and the base, a median narrow yellow stripe; on the hind wing, a broad and conspicuous yellow stripe. All the specimens had been labelled with Burchell's customary care and precision, and on a slip of paper attached to one of them, taken Mch. 10, 1826, at Rio de Janeiro, Westwood wrote—"69 individuals in full of this species without any variation of the least importance taken bet^{n} 24.10.25 † & 24.3.29. See list in my Burchell Catalogue." Opposite the list of dates copied from Burchell's labels into the catalogue above referred to, Westwood wrote "*Hel. Phyllis.* 69 ind^{s}" When a list of Burchell's Heliconinæ was prepared for publication ‡ by Mr. E. G. Joseph, B.Sc., a few years ago, 61 specimens out of the 69 were found in the Hope Department, but of these one had lost its label. Fifty-four of the 60 are the abundant Fabrician species *Heliconius erato phyllis*, 42 from the vicinity of Rio de Janeiro (Aug. 16, 1825—1; Dec. 6, 1825-Apr. 1, 1826—41); 10 from Minas Geraes (Oct. 14, 1825–Nov. 7, 1825); 1 from Santos (Sept. 19, 1826); 1 from Goyaz (Apr. 30, 1828). The 6 remaining specimens belong to two subspecies of the Opisogymni, a section of the genus different from that which includes *erato phyllis*. The latter belongs to Stichel's Section II, the Opisorhypari, in which the males are distinguished from those of Section I, the Opisogymni, by a narrower glistening area on the under side of the fore wing where it overlaps the hind. The Opisorhypari are as a rule the most abundant of the Heliconians and they are commonly mimicked by those Opisogymni which enter their areas of geographical distribution. A single one of the remaining six specimens is *Heliconius nanna*, captured by Burchell together with two of its models, *H. erato phyllis*, on Dec. 6, 1825, "in an

* *Trans. Ent. Soc. Lond.*, 1908, p. 507, n.

† This date is erroneous. The earliest date in Westwood's catalogue and on the specimens is 16.8.25. There are also other dates earlier than 24.10.25.

‡ *Ann. Mag. Nat. Hist.* ser. 8, vol. v., Apr. 1910, p. 322.

excursion to the summit of the Corcovado," near Rio. At first sight the model and the mimic are so precisely alike that we do not wonder at Westwood's statement that the whole series was "without any variation of the least importance"; but with a closer examination it is at once seen that the red bar of *erato phyllis* is sharply outlined while that of *nanna* is gradually transitional into the dark ground-colour. Thus one of the six Opisogymni is accounted for: the remaining five, all taken Mch. 2–24, 1829, at Porto Réal (Porto Naçionale) on the Tocantins River, came from outside and to the north-west of the area in which Burchell captured *erato phyllis*. All the dates in Westwood's catalogue are here to be found on the specimens, so that nothing is missing from this part of the collection. These five examples, although with a softly outlined red bar, are easily distinguishable from *H. nanna*, and if Professor Westwood had arranged the individuals geographically he would certainly not have maintained that the variation was without the least importance. For directly a geographical arrangement is made there separates out this little group of 5 individuals with patterns all very much alike, and all differing from those of the 55—54 models and 1 mimic—collected in another area lying to the south and east. In these 55 the lower outer border of the broad red bar is produced into two strongly marked projections or teeth. The same border in the 5 individuals from the north-west bears only the lower projection and this shortened and rounded. Examples in the collections of the British Museum and Mr. W. J. Kaye agree with those collected by Burchell. The difference is distinct but it is small—so small indeed that it had not only escaped the attention of Westwood in the museum but also of Burchell in the field; for the latter had noted concerning a specimen taken at Porto Réal on Mch. 2, 1829: "*Papilio*. The brown-winged (*Horta* *) with a red patch on the upper wings, is always found in shady woods and forests. I have seen it in similar situations in every part of Brazil I have visited." These words indicate that he looked upon all the specimens as belonging to a single species. But the difference, although small, is constant and forms the distinguishing feature of the north-western subspecies *H. nanna burchelli*. From this form there can be no doubt that *nanna nanna* has been produced to the east and south under the influence of the extremely abundant *H. erato phyllis*. Dr. H. Eltringham has shown in a paper† which will appear in the Transactions of the Entomological Society for the present year that the male genitalia of the two races are precisely similar although very distinct from those of *erato phyllis*, and he also agrees that *nanna* certainly arose from *burchelli* and not *vice versa*. We have then an excellent example

* It is shown, in *Ann. Mag. Nat. Hist.*, 1910, pp. 333–5, that by "*Horta*" Burchell meant to imply a place in the Fabrician "Heliconii."

† "On Specific and Mimetic Relationships in the genus *Heliconius*, L." *Trans. Ent. Soc. Lond.*, 1916, pp. 101–148, plates xi–xvii.

of the origin of a mimetic form by means of a variation in pattern so small as to deceive two extraordinarily observant naturalists, an example which at the same time provides evidence that small variations may be hereditary. This latter conclusion can only be escaped by assuming that the constant differences between these local forms are due to some unknown local influence and not transmissible by heredity. But Dr. Eltringham has shown in the memoir already referred to that both *nanna* and *burchelli* are only two out of a long list of geographical races into which *Heliconius melpomene* is split up, some of them with wide differences in pattern, some with small. Probably everyone would agree that the larger differences are of germinal origin and hereditary; yet large and small are all local races indistinguishable by the structure of the male genitalia. The onus rests upon those who would put them in different categories.

D. The Origin of a Mimetic Pattern.

The inheritance of small variations is closely connected with the problem of the origin of mimicry. Without such inheritance a likeness cannot have been gradually improved, and we should have before us no solution except that which assumes the sudden origin of an elaborate pattern resembling in wonderful detail that of some remote species. Such a solution has been proposed within the last few years, and it will be well to consider some of the difficulties which it encounters.

a. *A Mimetic Pattern supposed to arise suddenly from a set of Factors similar to those which produced the Pattern in the Model.*—This suggestion was first made by Professor Punnett, who maintained that on the Mendelian view "the genera *Amauris* [the Danaine model] and *Euralia* [the Nymphaline mimic] contain a similar set of pattern factors, and the conditions, whatever they may be, which bring about mutation in the former lead to the production of a similar mutation in the latter" *. This interpretation, although it does not carry us very far, has been accepted as satisfactory by some writers †. When it was pointed out that the patterns of model and mimic are only superficially alike and that, to name one obvious difference, the markings of *Amauris* were hard in outline and those of the mimetic *Euralia* (*Hypolimnas*) soft ‡, Professor Punnett replied that "it is not unreasonable to suppose that these species carry identical factors for colour pattern, and that the differences by which the eye distinguishes them are dependent upon the minuter structural differences such as occur in the scaling. So the eye would distinguish between a pattern printed in identical colours on a piece

* "Mendelism," 1911, pp. 134, 135.

† See for example the review by Francis B. Sumner in *Journ. Philos.*, New York, vol. ix. pp. 159–161.

‡ *Bedrock*, Apr. 1913, pp. 52, 53.

of cretonne and a piece of glazed calico. Though pattern and colour were the same the difference in material would yield a somewhat different effect"*.

The chemical nature of the colours of butterflies has not been much investigated, except in the *Pierinæ*, where the white, yellow, orange and red pigments of the mimics have been shown by Professor F. Gowland Hopkins † to be quite different from those of their models. But even without chemical analysis it is clear that the red of a *Pharmacophagus* swallowtail model is very different from the red of its *Papilio* or *Cosmodesmus* swallowtail mimic. Thus Professor Punnett, alluding to the quality of the red in the models of the two mimetic *Papilio polytes* females says: "in both models it is a strong clamorous red suggestive of a powerful aniline dye, whereas such red as occurs in the mimics is a softer and totally distinct colour" ‡. Hence in these two large classes of mimics, Pierine and Papilionine, the suggestion of identical factors in model and mimic cannot apply.

A critical examination of other models and their mimics constantly reveals difference under the apparent sameness of colour and pattern. I will mention a single example because it illustrates a physical rather than a chemical difference. Mr. S. A. Neave has told me that the semi-transparent white markings on the black and white species of the African Danaine genus *Amauris* appear blue when the insect is on the wing, an effect that can be witnessed by holding an opaque black surface beneath the pattern. It is not due to pigment but to the structure of the scales. Such a mimic of *Amauris* as the *hippocoon* female of *P. dardanus* only reproduces this effect very feebly, but the *Hypolimnas* (*Euralia*) co-mimics—e. g. *H. anthedon* in the west, and *H. wahlbergi* in the east—exhibit it strongly and in a form somewhat different from the model. The blueness is here in part due to a delicate iridescence of the white scales very similar to that of the *Amauris*, but also to intensely blue marginal scales, absent from the Danaine model, but common to many species of *Hypolimnas*, including the non-mimetic males of mimetic species and both sexes of the huge *H. dexithea* of Madagascar. The ancestral material of the genus *Hypolimnas* has been worked up into the mimetic likeness to a model which does not possess such material at all.

Assuming, however, for the sake of argument, that mimics exist in which the chemical and physical causes of colour are identical with those of their models §, it is important to enquire whether Professor Punnett's metaphor of patterns on cretonne and calico really help to explain the facts or only to disguise an essential difference.

* "Mimicry in Butterflies," Cambridge, 1915, p. 148.

† *Proc. Roy. Soc.* lvii. 1894, p. 5; and *Phil. Trans.* 1895, B. p. 661.

‡ "Mimicry in Butterflies," p. 82.

§ Instances doubtless occur where model and mimic are closely allied, as in the *Æneas* and *Lysander* groups of *Pharmacophagus* or the well-known convergent Danaine or Acræine groups.

b. *The Edges of Markings in the Patterns of Models and their Mimics.*—With certain exceptions—unimportant from our present standpoint—the pigments * of butterflies' wings are contained in the scales. Two colours do not occupy the same scale, but the passage from one colour to another is effected by a set of scales containing one pigment being replaced by a set containing another. In the examples referred to by Professor Punnett in the passage quoted on pp. 35, 36, the yellow scales are suddenly replaced by black scales at the margin of the hind-wing patch of *Amauris echeria*, while they are not suddenly replaced in the mimic, the *mima* form of *Hypolimnas dubius*. A part of the area that is wholly yellow in the model contains abundant scattered black scales in the mimic and so with part of the black area which in the mimic contains plenty of yellow scales. Scales that are yellow in the one are black in the other and *vice versa*. The difference is real.

The metaphor is also misleading in another way: it seeks to explain the difference as an incidental outcome of specific constitution unconnected with mimicry. But the soft outline is a common characteristic of the mimetic pattern just as the hard outline is of the model's. The *Hypolimnas* mimic is far more closely allied to the Danaine model *Amauris echeria* than either of them are to the Papilionine mimic, *P. dardanus*, yet both mimics exhibit the soft-edged pattern. They exhibit it in fore wing as well as hind: they exhibit it in all their other forms mimetic of other comparatively hard-outlined Danaine models. The following sentence, published by the writer fourteen years ago, refers to the most conspicuous and best-known black and white model and mimics in Africa:—". . . The white centre of the upper surface of the wings deepens gradually at its margin into black in both Papilio and Nymphalid, while the margin of the corresponding white area in the Danaine exhibits an extremely sharp and abrupt transition into black" †.

These differences between the edges or borders of markings on butterflies' wings are important and I propose for them the terms *eulegnic* (with a clear edge), and *dyslegnic* (with a dim or bad edge), the latter passing into *alegnic* (without an edge), kindly suggested to me by Professor Gilbert Murray ‡.

c. *Modes of Occurrence of Dyslegnic Patterns in Butterflies.*—Dyslegnic patterns are not only common in mimics as compared with models, but are also common in females as compared with

* The same argument applies to the physical causes of colour here omitted from consideration for the sake of simplicity.

† *Trans. Ent. Soc. Lond.*, 1902, p. 486, n. The passage refers to the hind wings of the western Danaine *Amauris niavius* and of its two mimics the *hippocoon* female form of *Papilio dardanus* and both sexes of *Hypolimnas* (*Euralia*) *anthedon*, also to the corresponding eastern and south-eastern forms—*A. niavius dominicanus*, *hippocoon* (or *hippocoonides* as it has been called in this area), and *H. wahlbergi*.

‡ λέγνον, an edge or border, with the prefixes ἐυ- good, δυσ- bad, or α- not.

males. Thus the mimetic female forms of *Papilio dardanus* bear in this respect the same relation to their Danaine models that they bear to their own male, and the female of the non-mimetic ancestor *P. meriones* in Madagascar is also far less eulegnic than its male. The dyslegnia has preceded the mimicry. If the brighter colours of male butterflies have been developed by sexual selection—and the fact that male brilliancy is due to interference colours as well as pigments strongly supports the Darwinian interpretation—it is also highly probable that their more eulegnic patterns have arisen in the same way.

When the sexes of a mimic are alike the male pattern as well as the female tends to be dyslegnic. This is commonly true in both sexes of the mimetic swallowtails of the section *Cosmodesmus*, as it is of the mimetic females of *Papilio*. An excellent example has already been described in the fore wing of *Heliconius nanna* with both sexes alike (p. 34).

In order to test the prevalence of dyslegnia in mimicking butterflies, I examined a considerable series selected many years ago as illustrations, and without any thought of this characteristic. Everywhere in the series the mimics were dyslegnic as compared with the models *. They included Nymphalines of various genera and Papilios of various species mimicking Danaines, Nymphalines mimicking Acræines, and *Acræa natalica* mimicking *A. anemosa*. The principle was commonly manifested by the Papilionine mimics of the *Pharmacophagus* Papilios of which a long illustrative series has been arranged in the Hope Department. One of the most striking examples is provided by the strongly dyslegnic patterns of all the forms of *Elymnias*, mimicking Danaine and Pierine models in the East and Acræine in Africa.

Having thus examined a number of well-known examples I thought it would be interesting to apply the test to newer instances only recently worked out in detail. Accordingly the attempt has been made to set forth in tabular form (Appendix, p. 51) the condition of the pattern edges in a series of similar patterns belonging to the two sections of the *Heliconinæ* referred to on p. 35. The series itself is fully described and illustrated in Dr. Eltringham's memoir† on the *Heliconinæ* now in the press and to appear shortly in the Transactions of the Entomological Society for the present year. Dr. Eltringham has kindly read the tabular statement and confirms the descriptions. Mr. W. J. Kaye, with a wide experience of the relative abundance of the

* The only exception that I encountered was the alegnic transition from orange-brown to black in the fore wing of *Danaida chrysippus*. In this butterfly and its mimic, the female *Hypolimnas misippus*, this transition appears to be real, being brought about by a gradual darkening in the colour of the pigment in the scales as the black area is approached—not by the "stippling" of the usual dyslegnic margin. In other respects the pattern of *D. chrysippus* is eulegnic (see p. 42). It is interesting to note that this alegnic transition from orange-brown to black is associated with extraordinary variability in the relative areas of the fore wing occupied by these two shades.

† See Note † p. 34.

forms in the two sections, has kindly added the notes which express what is known on this point. The table shows that on the whole the forms of Section I are more dyslegnic than those of Section II, but that one common feature in the pattern, the yellow bar of the hind wing, is generally eulegnic and often more so than in Section II. Now this bar is shown by Dr. Eltringham, for reasons which do not apply to Section II, to be probably ancestral in Section I. It must further be added that Dr. Eltringham shows that, with the possible exception of *H. pavonius*, all the forms in Section I mentioned in the Appendix are the races of a single species, and that the same is true of groups of forms in Section II such as the races of *H. erato* and *sapho*. Such evidence of recent change being common in Section II as well as I renders the table less applicable as a test of dyslegnia in relation to mimicry.

The facts in these *Heliconius* support the conclusion that the dyslegnic pattern is commonly found where there has been recent change as shown by close relationship with other forms, exhibiting slightly different patterns. Of course I do not assert that the eulegnic pattern never changes, only that dyslegnia is the usual accompaniment of change. Thus the Danaine model *Amauris niavius*, so often alluded to, has a pattern which is eulegnic except below the hind-wing cell: this is just the part which undergoes change, the border which advances, producing an immensely larger white marking on the east coast. Not only these, but the western race with a comparatively small patch and individuals from the east of the Victoria Nyanza with an intermediate patch, are all dyslegnic along the corresponding border. On the other hand the small spot in the fore-wing cell remains eulegnic throughout although it too increases in size on the east. But this is an extremely small change as compared with the other.

The dyslegnic pattern is also commonly found in single aberrations and in vestigial spots and markings. It predisposes to change and tends to persist as a register of change. It is often correlated with another predisposing cause of change—variability of colour.

E. Female Mimicry*.

It is here well to reprint the whole of a passage of which the latter part is as a rule only quoted. On p. 22 of his great paper (1865) Wallace, after describing the mimetic likeness of the females of certain Eastern Papilios to other presumably specially protected Papilios, continues:—

"The last six cases of mimicry are especially instructive, because they seem to indicate one of the processes by which dimorphic forms have been produced. When, as in these cases, one sex differs much from the other, and varies greatly itself, it may happen that occasionally individual variations will occur having a distant resemblance to groups which are the objects of mimicry,

* See also the author's "Charles Darwin and the Origin of Species." London, 1909, pp. 132–9.

and which it is therefore advantageous to resemble. Such a variety will have a better chance of preservation; the individuals possessing it will be multiplied; and their accidental likeness to the favoured group will be rendered permanent by hereditary transmission, and, each successive variation which increases the resemblance being preserved, and all variations departing from the favoured type having less chance of preservation, there will in time result those singular cases of two or more isolated and fixed forms bound together by that intimate relationship which constitutes them the sexes of a single species. The reason why the females are more subject to this kind of modification than the males is, probably, that their slower flight, when laden with eggs, and their exposure to attack while in the act of depositing their eggs upon leaves, render it especially advantageous for them to have some additional protection. This they at once obtain by acquiring a resemblance to other species which, from whatever cause, enjoy a comparative immunity from persecution."

In the earlier part of this passage Wallace clearly emphasises the rôle of female variability in the origin of female mimicry in butterflies, and later work tends to emphasise it still further. Considering such a common non-mimetic species as *Terias hecabe*, we find the bright eulegnic constant male is associated with a female having duller colours, dyslegnic pattern and much greater variability. Furthermore, the study of families with known parents bred by Mr. E. E. Green in Ceylon supports the conclusion that the degree of variability is hereditary. It is clear that the change to a new pattern would be far more likely to occur in the female of *Terias hecabe* than in the male, and that the particular kind of variability which I have called dyslegnia conduces to such a change. *Charaxes etheocles* affords another example. The females of this species mimic the females and sometimes the males of other larger species of *Charaxes*. I have recently received from S. Nigeria several specimens bred by Mr. W. A. Lamborn and by Mr. C. O. Farquharson; the females of these are non-mimetic and only differ from their males in the possession of an extremely obscure, unstable and highly dyslegnic pattern in paler tints dimly visible on the dark background of the wings—nevertheless, slight as it is, the expression of female variability.

Terias hecabe is an example of a species in which the sexes are nearly alike; when we consider those in which they are widely different the origin of female mimicry becomes much clearer. The most striking example known to me was brought to my notice by my friend Mr. S. A. Neave. I refer to the African Nymphaline butterfly, *Precis westermanni*, with an extremely constant male, although the pattern is somewhat dyslegnic, and a female varying in different directions with patterns of several kinds sometimes clearly, sometimes dimly suggested. There are orange-brown forms like the *dorippus* form of *Danaida chrysippus*, orange forms with dark fore-wing markings like *Precis sophia*, forms with dark fore wings—sometimes again shot with a purplish

iridescence—and orange black-spotted black-margined hind wings, similar forms with varying amounts of white and of orange in the fore wing and of white in the hind; finally, forms in which this white invasion is so extreme as to form a broad continuous bar crossing both wings. Furthermore there are immense differences in the breadth and the pattern of the dark margin of both wings. Here is a butterfly which seems to present ready-made, in the material afforded by female variability, the foundation of half a dozen different mimetic patterns.

A much less striking but still convincing example of the importance of female variability in the origin of mimicry is offered by *Pieris napi* described on pp. 27–29. Here the possibility for the development of new patterns is obviously much greater in the variable female than in the constant male.

A good example of an undoubted but very imperfect mimic—such a mimic as might easily arise from almost any of the female forms of *Precis westermanni*—is afforded by a form of *Pseudacræa albostriata* common, although not so abundant as the typical non-mimetic form, in the Entebbe district of Uganda. This local form with its white-barred hind wing and orange-red marked fore wing is clearly an outlying member of the great assemblage of mimics clustered round the powerful Acræine models *Planema poggei* and the male of *P. macarista*. I have only recently realised that it is an evident secondary mimic of another outlying mimic of the Planemas, the male of *Acræa althoffi*. In *Pseudacræa albostriata* both sexes are highly dyslegnic, but the female more so than the male; both have produced the local mimetic form, but the female's is more perfect than the male's. This too was only recently determined when all the best mimics were selected from the series collected by Mr. Neave, and it was found that they were all females and that those left behind were all males. The sex-linking here is confined to the degree of variation and does not involve its kind. The male and female are on the same path but the female keeps a little ahead.

F. Polymorphic Mimics and the Origin of Mimicry.

One of the most interesting and indeed exciting developments of butterfly mimicry in recent years is the immense increase in our knowledge of single species with many polymorphic forms resembling a number of models belonging to different species. The firm and solid foundation of this development lies far back in the three great monographs by Bates, Wallace, and Trimen, published in our Transactions in 1862, 1865, and 1869 *. But wonderful as was the discovery of the polymorphic mimetic females of Oriental Papilios by Wallace and of the African *Papilio dardanus* (*merope*) by Trimen, naturalists were certainly

* The two latter papers are often quoted as published in 1866 and 1870, the dates of the *volumes* in which they appear, but the *parts* were issued in each case in the previous year.

unprepared for the astonishing polymorphic mimicry of both sexes in the African forms of *Hypolimnas* proved by Millar, in the still more wonderful forms of the African *Pseudacræa eurytus* proved by Jordan and confirmed by breeding by Carpenter, and in the S. American Heliconine forms mentioned in the Appendix (p. 51) and proved to be conspecific by Eltringham. In all of these the transitional relationship between the patterns in each set of polymorphic forms can be traced and the conclusions based on pattern brought into line with those based on structure and on breeding. No such relationship exists (except in some of the *Heliconinæ*) between the patterns of any of the different species which contribute the set of models for each group of polymorphic mimics, and the whole series of facts strongly opposes Professor Punnett's hypothesis of the mutational origin of mimicry from a set of factors identical with those which produce the pattern of the model.

I propose now briefly to consider the best known and most striking of the much rarer cases in which the models as well as their mimics are polymorphic; for here if anywhere in polymorphic mimicry we should expect to find evidence in favour of Professor Punnett's hypothesis. I refer to *Danaida chrysippus* with its three forms *chrysippus*, *alcippus*, and *dorippus*, all of which are well known to be mimicked in Africa by the female of *Hypolimnas misippus*, and by both sexes of *Acræa encedon*, while the first and last are mimicked by two forms of a *Mimacræa* (*Lycænidæ*) probably belonging to the same species. Here then are three forms of a model mimicked respectively by three forms of the female of one mimic and both sexes of another. It might be expected that the latter at any rate, for the model also is polymorphic in both sexes, would present the essential similarity due to the appearance in both of the same pattern factors. But as I pointed out in 1902 * the different forms of *chrysippus* are far more sharply separated from one another than those of its mimics. All three of the latter show a much wider range of pattern variation and especially of transition between their polymorphic forms. And this is conspicuously evident in *Acræa encedon* with both sexes polymorphic. Accompanying these characteristics of the mimetic pattern there is the usual dyslegnia, while the model is eulegnic except in the feature described on p. 38, Note *.

a. *Polymorphic Forms, — Mimetic Constant and Non-Mimetic Variable,—in the Same Species.*—In another respect recent discoveries in the polymorphic mimics throw light upon the origin and growth of mimicry, strongly supporting the Darwinian interpretation. Thus Dr. Carpenter has shown † that in certain islands in the N.W. of the Victoria Nyanza where for some reason the mimics are much commoner than their models, intermediates

* *Trans. Ent. Soc. Lond.*, 1902, pp. 483, 484.
† *Trans. Ent. Soc. Lond.*, 1914, pp. 606–645.

Alfred Robinson, photo.

Papilio dardanus. Family bred by W. A. Lamborn in S. Nigeria (1913) from *hippocoon* ♀ parent (Fig. 1), including one ♂ (Fig. 2) out of 15, and all ♀ offspring 9 *hippocoon* (Figs. 3–11), mimicking the dominant Danaine *Amauris niavius*, constant; 8 *dionysus* (Figs. 12–19), without a model, variable. $\frac{2}{3}$ of natural size.

between the forms are much commoner than on the adjacent mainland of Uganda where Mr. C. A. Wiggins has shown * that the models are more abundant than the mimics. No reasonable interpretation has been suggested except the one proposed by Dr. Carpenter—that natural selection operates more stringently in the preservation of the mimetic forms in one area than in the other. Confirmation of a remarkable and striking kind has been obtained by Mr. W. A. Lamborn †, who in 1913 bred from a black-and-white *hippocoon* female of *Papilio dardanus*, captured near Ibadan in S. Nigeria, the female offspring all of which are represented in the accompanying plate 1. Of the 15 male offspring only a single one is shown (Fig. 2). Of the female offspring 9 (Figs. 3–11) are seen to be *hippocoon* like the parent (Fig. 1), while 8 (Figs. 12–19) are the remarkable form *dionysus*, well known but never common all along the tropical West Coast of Africa. *Dionysus* exhibits a strange combination of the patterns of certain mimetic females of *dardanus* with features that are ancestral or reversionary. It is itself non-mimetic, for the one rare Danaine (*Amauris fenestrata*) which is something like it is only recorded from the French Congo. And just as Dr. Carpenter found that the mimetic forms varied away from their models and ran into each other in the islands where the models were few, so this single form, without a model, varies in the localities where its sister-forms, with their models, keep relatively constant. *Dionysus* has never been bred until Mr. Lamborn reared the butterflies here represented, and proved that this relationship holds even within the limits of the same family. It is highly probable that the proportions are Mendelian and the result of a recessive female parent mating with a heterozygote male, and that all the *hippocoon* offspring are recessive and all the *dionysus* heterozygote, but this does not explain the variability of the latter. Mr. C. F. M. Swynnerton has bred families in S.E. Rhodesia which, on the same grounds ‡, are probably made up of recessives and heterozygotes, but in all of these except one all the female forms are mimetic and constant. The single family which forms the exception includes like Dr. Lamborn's a variable non-mimetic female form and a constant mimetic one.

The ancestral part of the pattern of *dionysus* is seen in the fore wing, and the eight specimens have been arranged in the plate to exhibit the gradual transition from Fig. 12 with its fore wing resembling a *hippocoon* (Figs. 3–11) with the triangular white patch of an unusually large size, to Fig. 19 with its fore wing

* *I. Congr. Internat. d'Ent.* 1910, vol. ii. p. 483; also *Proc. Ent. Soc. Lond.*, 1911, pp. xci–xcv.

† *Proc. Ent. Soc. Lond.*, 1914, pp. lxiii–lxvi. See also pp. lxvii–lxxi; also *Bedrock*, Apr. 1914, pp. 36, 37, 39. When this latter article was written the whole family had not been received, so that the number of *hippocoon* is given as 6 instead of 9.

‡ See *Proc. Ent. Soc. Lond.*, 1914, pp. lxviii–lxx; see also pp. lvi–lxiii.

resembling the non-mimetic male (Fig. 2), and still more closely the non-mimetic females of the Madagascar *P. meriones*. It is noteworthy that the triangular fore-wing patch shown in Fig. 12 is more dyslegnic than in any *hippocoon*, although *hippocoon* itself contrasts strongly with the eulegnic model *Amauris niavius*. From Fig. 12 onwards towards Fig. 19 the amount of dyslegnia increases until the bar itself has gone, being represented only by a dusting of dark scales, of which a trace can still be detected in Fig. 19.

The results obtained by Dr. Lamborn, and here represented in the plate, taken in conjunction with Dr. Carpenter's researches in the N.W. Victoria Nyanza and Mr. C. F. M. Swynnerton's in S.E. Rhodesia, offer very strong evidence that the constancy of the mimetic forms which have been the subjects of investigation is due to the operation of natural selection in the presence of the appropriate models, and that when such models are scarce or absent the constancy is no longer maintained on the same level. It is furthermore important that Dr. Carpenter has observed that variations such as those shown in the oblique fore-wing bar of *dionysus* are quite conspicuous on the wing *; and if they are such as to constitute departures from the pattern of the model, there is no reason for believing that the difference is less evident to the eyes of their natural enemies.

G. The Beginning of Mimicry: the First Step.

Alluding to the resemblance of Chalcosiine moths of the genera *Amesia* and *Callamesia* to the dark blue-shot Euplœas of India, &c., I wrote in 1890 †:—"There are also examples which show us the origin of mimicry—examples in which the resemblance is very imperfect, but, nevertheless, sufficient to afford some protection. .... It is extremely probable that the wonderfully close likeness of many mimetic species arose by gradual stages from a general resemblance to a type of colour or pattern possessed by a large group of unpalatable insects." In 1912 I discussed ‡ the origin of the mimetic Uganda female of *Acræa alciope*, which resembles the male of *Planema macarista* and the male and female of *P. poggei*. I gave reasons for the belief that the resemblance to these Uganda models was started by the sudden appearance of a white bar crossing the hind wing. It was also shown that variations of this kind do arise; for out of 294 S. Nigerian females bred by Mr. W. A. Lamborn, a single one exhibited a well-marked white bar crossing the fore wing, thus showing "how a mimetic modification might arise if an appropriate model existed

* *Bedrock*, Oct. 1913, pp. 360, 361; Apr. 1914, pp. 34, 35.

† *Nature*, Oct. 2. Reprinted in "Essays on Evolution," Oxford, 1908, p. 376.

‡ *Bedrock*, April 1912. p. 48; quoted in *Bedrock*, Oct. 1913, pp. 301, 302, which should also be consulted, together with the No. for Apr. 1914, p. 45.

in the locality." The origin of the Uganda mimic was suggested in these words * :—"It is probable that by spontaneous variation a white band .... appeared in the ancestral form .... and that this was from the very first sufficient to confer some advantage by suggesting the appearance of a dominant Model. .... From this point Natural Selection acting on further variations produced the detailed likeness which we see in the white band itself and in the other mimetic features." After these words were written the opportunity was afforded me of studying Mr. S. A. Neave's collection of butterflies from the Semliki Valley the W. boundary of Uganda, and the forest patches near it. "In his whole collection from this part of Uganda there is not a single mimetic female *alciope* of the eastern [viz. E. Uganda] type: there are many females of the western type, and of these a considerable proportion bear the incipient bar developed to a very variable extent, and sometimes appearing on the under surface alone. Here, then, in the very zone of country where, on the theory of mimicry, we should expect them to be, we meet with the earliest stage of the eastern mimic, but, so far as we know, never the finished product" †.

The results cannot be explained by climate or any other of the physico-chemical influences of a locality, for the ancestral stage persists into E. Uganda although it is very rare as compared with the fully-developed mimic ‡.

I conclude this section with the following general statement made nearly three years ago § :—"I have always recognised that the first variation must be something appreciable, something which, at any rate, at a distance and on the wing would recall the pattern of the model. Mimicry is far more characteristic of forest species than of those living in the open, and Mr. C. F. M. Swynnerton has made the reasonable suggestion that the origin of mimicry is facilitated by the alternating light and shade of a tropical forest, where it is easy to confuse patterns readily distinguishable under ordinary conditions of illumination" ‖.

I wish to emphasise these earlier statements because, as will appear in the next section, my position has recently been misunderstood.

a. *The Beginning of Mimicry in the North American Nymphaline Butterfly*, Limenitis archippus.—One of the most beautiful and elaborate examples of butterfly mimicry in the world is found in a North American "White Admiral" (*Limenitis*) whose pattern has been profoundly modified in mimicry of invading Danaines. The

* *Bedrock*, Apr. 1912, p. 63.
† *Bedrock*, Oct. 1913, p. 303.
‡ *Bedrock*, Apr. 1914, pp. 35, 36.
§ *Bedrock*, Oct. 1913, p. 301.
‖ For the special development of mimicry in forest areas, see *Proc. Ent. Soc. Lond.*, 1912, pp. l–liii.

mimetic pattern has been analysed * by the present writer, who has compared its elements with those of the commonest non-mimetic N. American *Limenitis*. The general results of the comparison are briefly stated below:—

"The difference between the pattern of the mimic [*Limenitis archippus*] and that of its non-mimetic parent [*L. arthemis*] is enormous—probably as great as that between any two butterflies in the world; but the steps by which the transition was effected were long ago suggested by S. H. Scudder . . . . " †.

"A careful comparison between *arthemis* and *archippus* reveals the most conclusive evidence of selection. The one species has become changed into the other precisely as if an artist were to paint the pattern of *archippus* upon the wings of *arthemis*, retaining unchanged every minute part of the old markings that could be worked into the new, and obliterating all the rest. Thus, extending in this direction and wiping out in that, the great transformation has been effected and one of the most beautiful mimics in the world produced" ‡.

Professor J. F. Abbott has recently criticised § these conclusions or rather his own inference from them—an inference which I am very far from accepting. Professor Abbott takes as his basis the following statement of the selectionist principle as applied to these superficial resemblances:—"In mimicry the selecting influence of the model, if we may use such a term, will be constantly operative upon all individuals of the mimicking species wherever the two are associated in the same habitat" (p. 208). These words are an overstatement, for the selectionist does not claim an influence upon every individual. Exceptional failures in the mimetic likeness may and do survive even when the model is abundant ‖. But it is the following inference from the statement which is especially open to criticism—"it would seem probable therefore, in the case under discussion, that in the districts where *Anosia* [the model] and *L. arthemis* [the hypothetical non-mimetic ancestor of the mimic] occur together, the latter would constantly show in some way the influence of the selective factor. Even if no incipient *L. archippus* is to be found,

* *Trans. Ent. Soc. Lond.*, 1908, pp. 447–488.
Ann. Ent. Soc. America, ii. 1909, pp. 203–242. Also published in "Darwin and the Origin," London, 1909, pp. 144–212.
Proc. Acad. Nat. Sci. Philad., Jan. 1914, pp. 161–194: issued Apr. 21, 1914.

† "Darwin and the Origin," p. 165.

‡ "Darwin and the Origin," pp 165, 166.

§ "Mimicry in the genus Limenitis with especial reference to the 'Poulton hypothesis,'" *Washington Univ. Studies*, vol. i. Pt. I, no. 2, Jan. 1914, pp. 203–221.

‖ Numerous instances might be given. One of the best has been already described in the non-mimetic *dionysus* form of *P. dardanus* on the W. Coast of Africa (see pp. 43, 44). No doubt "the selecting influence of the model" keeps the mimetic female forms of *dardanus* common, while the absence of a model keeps *dionysus* rare, but it does not prevent the existence of this latter form or of the very rare non-mimetic *leighi* form in Natal.

an aggregate of individuals of *arthemis* ought to show a tendency in that direction by virtue of the fact that by hypothesis the *surviving* adults would be those whose resemblance to the immune *Anosia* has been the means of their preservation from destruction" (p. 208).

I regard this inference as quite unsound. I do not believe that the presence of the Danaine model, *plexippus*, has the slightest effect upon the pattern of *Limenitis arthemis*. A colour variation sufficient to cause the one butterfly to be mistaken for the other at any rate under certain circumstances of movement, or distance, or light and shade, &c., must have preceded the evolution of the mimetic pattern as we now see it. If I had thought it possible that such an inference would have been drawn, the present statement would have found a place in the original paper.

Professor Abbott furthermore infers that I committed myself to the belief that the evolution of various elements in the mimetic pattern was simultaneous * (p. 215). I did not intend to express any such belief: I do not hold it. The 1908 paper criticised by him was concerned with an analysis of the fully-formed mimetic pattern of *L. archippus* and the identification of the modified ancestral elements in it—not, except in the most general way, with the sequence or simultaneity of their evolution. I regarded this as a far more speculative matter, perhaps incapable of solution, at any rate not the subject in hand.

Professor Abbott's measurements of colour elements in the pattern of *Limenitis arthemis*, interesting and valuable as they are in themselves, do not affect my conclusions. He finds no evidence of "selection with reference to the mimetic colours" (p. 220) of this non-mimetic species, and I should expect none. I admit that Scudder's statement † quoted by Professor Abbott (p. 204, n. 3) does suggest that the mimicry started in small variations of the orange or red elements in the pattern, but even here there is no suggestion of simultaneous evolution in the other elements. I freely admit too that my own statement ‡ was open to Professor Abbott's interpretation as regards the reddish elements, and these alone,—the very elements which he finds to

* Note also the following passage on pp. 217, 218:—"On the basis of Professor Poulton's hypothesis we should expect not only that a selective influence should be evident both in the reduction of the white band and the extension of the red patch, but also that the majority of the surviving individuals [of *arthemis*] should combine these effects."

† "Individuals among the normal species vary somewhat in this particular, so that it is easy to suppose that some of the original *archippus* with more orange than usual may have escaped capture on occasion from this cause. From such a small beginning such as one may now see every year in *B. astyanax* sprang doubtless the whole story...." Scudder's statement seems to me to imply that the reddish elements enlarged first while the other changes followed later. I admit that I have never seen an *astyanax* with the reddish tint so extended as to suggest a probable first step towards the mimetic likeness, but my experience is of course very small compared with Scudder's.

‡ "The character in *arthemis* which initiated the mimicry of *Anosia* is the submarginal row of reddish spots, commonly found in the hind wing, more rarely in the fore" (1908 paper, p. 456).

be specially variable. But, as I have said, it was not my object to attempt, nor did I attempt, to suggest the evolutionary stages in their order, nor the pattern of the hypothetical variety which started the mimetic pattern.

Now that the question has been raised I am quite ready to express my opinion for what it is worth on so speculative a subject. I believe that the evolution of the mimetic pattern could not have begun upon the upper surface until the appearance of a variety in which a reddish or orange tint had largely replaced the dark ground-colour, and could not have begun upon the lower until a similar or paler tint had replaced the dark chocolate-brown. The wide range of variation in the reddish elements of the pattern referred to by Scudder and proved to exist by Professor Abbott's measurements requires to be greatly extended before the mimetic pattern could begin to arise; but, after that, the pattern was gradually elaborated by the selection of small variations. I believe that the hypothetical ancestor was a butterfly which, as it sailed after the manner of a *Limenitis*, appeared to be of an orange or reddish colour with a broad white band crossing both wings. From this foundation I believe selection has gradually built up the detailed likeness which we see in *obsoleta* and still more perfected in *archippus*.

Professor Abbott has shown by measurements of many individuals that in *arthemis* the white band is a very stable structure (p. 218), as indeed I should have expected from its long persistence in *Limenitis obsoleta* with its beautifully mimetic pattern. The comparison of the Danaine-mimicking North American forms of *Limenitis* with *L. astyanax*, which, although a very close ally of *arthemis*, is without the white band, strongly suggests that it has been a much easier task to get rid of this feature altogether than to mould it in the fore wing into the likeness of the model. Evidence that it is most persistent and has nevertheless been so moulded is afforded by the vestiges which still cling in out of the way places to the mimetic pattern but do not contribute to it, which indeed even slightly diminish the likeness to the model. A feature of especial interest in this respect is the distinct trace of the lower (inner marginal) end of the white band on the fore wing of *L. obsoleta*.

H. Mimicry between the Different Insect Orders.

The inadequacy of the hypothesis that mimetic resemblance arose at a single bound can be shown by innumerable instances of such likenesses between insects of different orders. I will speak of only a single example, and choose it from among "the species of *Scaphura* (a genus of Crickets) in South America [which] resemble in a wonderful manner different Sand Wasps of large size"*, because they are mentioned in Bates' historic

* H. W. Bates in *Trans. Linn. Soc.*, xxiii. 1862, p. 509. *Scaphura* is now placed among the *Locustidæ* (*Phasgoneuridæ*) and not in the *Achetidæ*.

memoir and also because I have recently had the opportunity of studying the details of the mimetic likeness *. The antennæ of the Fossorial Wasps, the models, are of moderate length (about one third that of their mimics), rather stout with a peculiarly emphasised annulation, in colour usually black with a yellow tip. The antennæ of the *Locustidæ* are very long, of almost hair-like fineness, the annulation inconspicuous, the colour uniformly dark with no change at the tip. The antenna of *Scaphura* possesses all the *Locustid* characteristics for the distal two thirds of its length. The basal third, however, is thickened to the diameter of the Fossor's antenna: it has a strongly pronounced annulation and its terminal segments are yellow. At a little distance the hair-like two thirds are invisible and all that is seen is the thick yellow-tipped part resembling the entire organ of the model. To these mimetic details must be added a blue-black iridescence of the abdomen, and above all the great modification which has taken place in the movements, involving changes in the nervous and muscular systems; for the Locustid resembles its Fossorial model and departs from its own group in "the very curious habit of flying and running alternately and of running short distances with expanded wings" †.

It is unreasonable to suppose that such a resemblance as this can have been evolved except by successive stages and in the course of a long period of time.

I. Conclusion.

It may be considered that it was unnecessary to devote my last Presidential address to the attempt to prove that small variations are inherited and that mimicry once started has been evolved by the accumulation of small hereditary variations. I have done so because the subjects happen to be those at which I have worked for many years, but also because the views I have attempted to controvert are typical of a restless spirit which, without any real knowledge or serious investigation, seeks to overturn and to destroy. Destructive criticism based on research is a very different thing from an offhand attempt to call in question.

To throw doubt on the germinal origin and hereditary nature of the differences which distinguish geographical races, and thus on the reality of the races themselves, is merely a manifestation of that gratuitous and unnecessary disturbance which, especially in this country, has accompanied much interesting and excellent work at the present day. Although sufficiently disconcerting to those students of geographical biology who take these hasty and unfounded conclusions too seriously, it is however but a slight effort of the "spirit that denies", as compared

* *Proc. Ent. Soc. Lond.*, 1913, pp. l–liii.

† On the evidence of Dr. Adalbert Seitz, who has often seen model and mimic flying in the same locality near Santos, Brazil. *Proc. Ent. Soc. Lond.*, 1913, p. li.

with the outbreak at Melbourne in 1914 when naturalists were invited to contemplate the whole process of organic evolution as a procedure from the infinitely complex to what by comparison is absurdly simple,—from a Protozoon which contained within it the material germs of all that has been and all that might have been, and, added to these, first the controlling mechanisms which prevented such germs from developing, and then, implied in the last, some mechanism determining the order of their release—from all this to man himself, a mere jack-in-the-box, or rather a combination of jack-in-the-boxes, which, before their lids sprang open, were handed down through the ages,—just one bundle made up out of the infinite variety of finished goods that poured forth, all securely packed, from that illimitable warehouse—the unicellular ancestor! Assuredly he who would suggest this will, in his own words, "be wise to base his faith frankly on the impregnable rock of superstition" *.

And now that my term of office has come to an end I wish to express my gratitude to my brother officers and to the members of Councils and of the Society who have made my task so easy and so pleasant—to the Treasurer, the Botanical Secretary and the General Secretary, who had long been in office when I was first elected and have been my kind and sympathetic colleagues and friends for four years. I desire to thank Professor Bourne who gave me kind help as Zoological Secretary until he was obliged to resign in answer to his country's call. We mourn and zoological science mourns the loss of Dr. Assheton who would have been his successor, and of Professor Minchin who held the post for a few short months. And finally I wish to thank my kind friend Mr. Goodrich the present Zoological Secretary who happily will continue to give his help to my distinguished successor.

And here I would speak in few words of Raphael Meldola, not a Fellow of our Society but with us in spirit and one of the band of friends—Darwin, Wallace, Bates, Fritz Müller, and Trimen—who have revolutionised, and largely by means of the Linnean Society, the sciences that are grouped together under the general term Natural History. [And as I am revising the manuscript of this address for publication the last survivor Roland Trimen has passed from among us, so that in under three years we have lost two out of the three authors whose great monographs, published in our Transactions about fifty years ago, laid the foundations of the study of Mimicry in insects.]

How different would have been the feelings with which you would have attended this meeting and with which I should have addressed you, if the happy conditions of the first half of my term of office had been prolonged to the end. But this was not to be; and my debt is all the deeper for the helpful and kindly sympathy which we have received. But I do not wish to dwell

* *Report British Association*, 1914, p. 11.

on personal and private sorrow as a thing apart. The times call for a wider outlook.

Before the greatest calamity of all time has finally passed away well-nigh every home throughout the land will have known its own pride and its own grief, felt and endured with no bitterness of isolation nor recoil from the intermeddling of strangers, but in fullness of understanding and sympathy made one with national pride and grief.

A nation, and not one nation only but a federation of many nations, thus knit together, will provide a sure foundation for the fearless social and political reconstruction that must inevitably come. In this noble work Science will take a far larger share than she has had in the past, and I am happy in the knowledge that this great Society, under the guidance of my successor and of those who come after him, will hear the inspiring call and give a splendid answer.

Appendix.

The Pattern Edges in Pairs of Heliconine Forms. Each pair consists of model and mimic belonging to different Sections. The model apparently belongs more often to Section II.

Heliconius. Sect. II. Opisorhypari.	*Heliconius.* Sect. I. Opisogymni.	Comparison of pattern edges.
H. egeria egerides. Much rarer.	*H. melpomene funebris - cybele.*	Both dyslegnic. *Cybele* slightly but distinctly less so in yellow of F.W. and red of H.W.
H. burneyi huebneri.	*H. melpomene thelxiope.* Commoner.	Nearly same. Yellow of F.W. rather more eulegnic, "nail-head" radii of H.W. rather more dyslegnic, all red of H.W. under side much more dyslegnic in *thelxiope.*
H. hewitsoni. Not common; occurs higher but probably overlaps.	*H. pachinus.* Very common but extremely local.	All yellow rather dyslegnic, a little more so in F.W. especially apical marking.
H. sappho primularis. Commoner.	*H. cydno alithea.*	Chief yellow patch of F.W. more eulegnic in *primularis*: H.W. yellow margin less so than in *alithea* and, being much broader than in *sappho eleuchia*, recent change is probable as compared with *alithea* whose H.W. margin is same width as *cydno epicydnides.*
H. sappho eleuchia. Commoner.	*H. cydno epicydnides.*	F.W. main patch rather more dyslegnic, H.W. margin rather less so in *epicydnides.*
H. sappho leuce. Commoner.	*H. cydno zelinde.*	*Zelinde* distinctly more dyslegnic.
H. himera. Probably commoner.	*H. melpomene timareta contiguus.*	F.W. rather, H.W. distinctly more dyslegnic in *contiguus.*

Heliconius. Sect. II. Opisorhypari.	*Heliconius.* Sect. I. Opisogymni.	Comparison of pattern edges.
H. microclea.	*H. xenoclea.* Commoner.	Both eulegnic. *Xenoclea* rather less so at basal edge of central F.W. patch.
H. microclea notabilis.	*H. melpomene xenoclea plesseni corona.* Apparently commoner.	*Corona* more dyslegnic with far more scattered red scales in F.W. Red scales in white F.W. patch denser in *notabilis.*
H. erato rothschildi. Very few known.	*H. melpomene aglaope.* Fairly common.	F.W. dyslegnic in both: "nail-head" pattern of H.W. in *aglaope* far more dyslegnic.
H. hydara chestertoni. Much commoner.	*H. weymeri gustavi.* True ab. *gustavi* quite rare, but *weymeri* still scarce, probably because it occurs much higher.	Yellow H.W. bar, the only marking, dyslegnic in both, but more so in *chestertoni.*
H. hydara columbina. Much commoner.	*H. amaryllis rosina.*	F.W. red much more eulegnic in *columbina*: H.W. yellow more so in *rosina.*
H. erato phyllis. Certainly commoner.	*H. melpomene amandus.*	H.W. yellow equally eulegnic. F.W. red far more so in *phyllis.*
No species taken by Burchell (pp. 33, 34).	*H. nanna burchelli.*	Dyslegnic red patch in F.W.: eulegnic yellow bar in H.W.
H. erato phyllis. Very much commoner (pp. 33, 34).	*H. nanna nanna.*	H.W. yellow equally eulegnic: F.W. red far more so in *phyllis.*
H. erato anacreon ottonis. Rare.	*H. melpomene penelope margarita.* Rather uncommon.	Curious fusion of different patterns, very suffused and dyslegnic in both. The large yellow F.W. patch of *margarita* more eulegnic, with appearance of having replaced a eulegnic red patch of which traces remain externally.

Dr. D. H. Scott, F.R.S., then moved:—"That the President be thanked for his excellent address, and that he be requested to allow it to be printed and circulated among the Fellows," which, being seconded by Mr. E. T. Browne, was put to the Meeting, and carried by acclamation.

The President having acknowledged the vote of thanks, addressed Mr. Frank Evers Beddard, F.R.S., and recited the services to zoological science which had decided the Council to award the Linnean Medal this year to him.

He said: Since 1884 when you became Prosector to the Zoological Society, you have published a multitude of papers on varied subjects, chiefly on the comparative anatomy of mammals, birds,

reptiles and amphibia, but also on the skeleton, the brain, the respiratory and digestive organs, myology, and more especially on the vascular system.

But your famous work on Oligochætes, particularly Earthworms, opened up a new field of quite unexpected interest; your account of the important variety and interest of the nephridia and reproductive organs made a great advance not only in comparative anatomy, but also in the description of new forms, and in classification and geographical distribution you became the first authority. Since then you have devoted much labour on parasitic cestode worms.

I may allude to your chief general publications, besides your Monograph on Oligochætes, books on Geographical Distribution, Animal Coloration, the Structure and Classification of Birds, the volume on Mammalia in the Cambridge Natural History series, and on Whales.

It is an additional pleasure to me, on handing you this Linnean Medal, to recall our old acquaintance and friendship from a period of forty years ago at Oxford.

The recipient made a feeling and suitable reply.

The General Secretary placed obituary notices of deceased Fellows before the Meeting, and the proceedings terminated.

OBITUARY NOTICES.

Reginald Gervase Alexander came of a family settled in Halifax for several generations; his father and grandfather having been medical men, he followed the same profession. He was born in that town on the 20th February, 1847, was educated at Shrewsbury School, under Dr. Kennedy, went to Caius College, Cambridge, there graduating with honours in 1874, and subsequently proceeding M.A., thence migrating to King's College, London, and still further studied at Edinburgh, emerging with the degree of M.D.

His medical career was a distinguished one, and he was an early practitioner in the open-air treatment of consumption, on which he published several works.

In 1912 he was declared by the House of Lords a co-heir of the ancient baronies of Burgh (1529) and Cobham of Kent (1313); also claimant to the Peerage of Strathbolgie. He died at Halifax, on the 14th February, 1916, of heart-failure, leaving two sons and two daughters, his wife having predeceased him by two years. He became a Fellow of the Linnean Society on the 19th April, 1888. [B. D. J.]

Richard Assheton, D.Sc., F.R.S., F.Z.S.—By the death of Dr. Assheton in October 1915 the Linnean Society lost a brilliant member. Dr. Assheton belonged to that sadly dwindling band of enthusiasts, who, being raised by the possession of adequate private means above the necessity of a constant struggle for their daily bread, are content to devote all their life and energy to biological research. Although he held several most inadequately remunerated teaching posts during his life, his object in doing so was mainly to vitalize his research by the opportunities which they afforded him of coming into contact with younger workers and students.

Dr. Assheton was born at Downham Hall, in Lancashire, in 1863. He was educated at Eton and afterwards at Trinity College, Cambridge. He took his degree with first-class honours in Natural Science in 1886, one of his principal subjects being zoology. After his degree he devoted himself to research in embryology, for at that time the School of Comparative Embryology, founded in Cambridge by F. M. Balfour and carried on after his death by Adam Sedgwick, was at the height of its development.

In 1889 he became demonstrator in zoology in the Victoria University, Manchester, under Prof. Milnes Marshall, and held this post until Prof. Marshall's death in 1893. Whilst at Manchester he produced in conjunction with his colleague Dr. Robinson his first original memoir. This dealt with the fate of the primitive streak and its equivalent in the Frog. In this paper we catch a glimpse of the principle which governed all Dr. Assheton's subsequent research, viz., the effort not to be content with describing appearances but to penetrate to the analysis of the *processes* which are the active agents in development. It was demonstrated that the tail of a vertebrate is an organ which owes its existence to a secondary zone of growth, and is not a part of the body left behind by an imaginary and impossible movement of the anus forwards in relation to the other viscera.

After leaving Manchester Dr. Assheton settled at Grantchester, near Cambridge, where the remainder of his life was spent. A long succession of valuable researches was carried out by him in his private laboratory. For a while he devoted himself to the difficult subject of mammalian embryology, and he investigated the early stages of development in the Sheep, a most costly piece of research. He was led to a view of the early development of Mammalia with which we cannot agree: for he regarded the layer of cells forming the wall of the blastodermic vesicle as endodermic, instead of being ectodermic as the majority of embryologists held it to be. Thereafter he undertook a series of valuable experimental work on the development of the Chick. He devised a method of opening the egg and keeping the embryo alive, so that its growth could be watched and measured with respect to fixed marks. By this work he extended and confirmed

his former work on the primitive streak, and proved that the view that the whole vertebrate embryo is formed by the concrescence of two folds is erroneous: he showed, however, that a great part of the length of the vertebrate, and not merely the tail, is due to the activity of a secondary zone of growth at the posterior end, and to this secondary growth he gave the name *deuterogenesis*. All subsequent careful research has confirmed Assheton's view, and his analysis of the earlier stages in vertebrate development may be regarded as his great contribution to zoological science But his researches were not by any means confined to this subject. He gave an account of the development of that curious fish *Gymnarchus niloticus*, based on material brought back from Egypt by Budgett. He described a new species of *Loxosoma*, and at the time of his death he was engaged on a valuable monograph on the anatomy of a British species of *Balanoglossus*. In addition he had almost completed a text-book of Mammalian Embryology.

Assheton's untimely death was a real tragedy for British zoology. We have far too few investigators with either his opportunities or his ability to carry out experimental researches like his; and yet researches of this kind throw more light on the real "inwardness" of the processes of development than any amount of purely descriptive work.

In 1901 Dr. Assheton was appointed lecturer in biology in Guy's Hospital, London, and held this post until 1914, when he resigned it in order to accept the position of lecturer in animal embryology in the University of Cambridge. In the latter year also he received the well-merited honour of the Fellowship of the Royal Society; an honour which alas! he lived little more than a year to enjoy.

Dr. Assheton married the daughter of Sir Thomas Bazley, Bart., and had a family of three, one son and two daughters. His son accepted a commission in the 1st Cambridgeshire Regiment at the outbreak of war. We are glad to learn that his widow, who is also a Cambridge zoologist, is engaged in revising the work which he left unfinished, so that we may entertain the hope that none of it will be lost to the scientific world. Dr. Assheton had a wide circle of friends who will miss sadly his kindly and endearing presence.

He was elected a Fellow of this Society on 1st June, 1893.

[E. W. MacBride.]

Frederick Manson Bailey, Colonial Botanist of Queensland, died at Brisbane on June 25th, 1915. He was born in Hackney on March 8th, 1827, and therefore in his 89th year at the time of his death. In 1838 his father, John Bailey, who belonged to a family of nurserymen and seedsmen in London, took him to Australia. The father was appointed Government Botanist of South Australia and laid out the first botanic garden at Adelaide, but finding himself subsequently obliged to resign the post, he set up as nurseryman. Young Bailey assisted his father in the new business

for some time, but went afterwards to Victoria, then to New Zealand, and, finally, in 1861, to Brisbane, where he established himself as seedsman. His practical experience and professional knowledge brought him to the notice of the Queensland Government, who, in 1875, appointed him to investigate certain botanical problems which had arisen in connection with animal and plant diseases. This led subsequently to his appointment as Curator of the botanical section of the Queensland Museum, and in 1884 as Colonial Botanist. He devoted himself with singular energy and zeal to the botanical exploration, and to more immediately practical problems of the agriculture of Queensland. He published a 'Flora of Queensland' in seven volumes, a 'Handbook of the Ferns of Queensland,' and a number of papers dealing with systematic and economic matters, for which he felt a keen interest right up to the last days of his long life. The depth and character of his enthusiasm for his science may be gauged from the fact that, when in the nineties the post of Colonial Botanist was abolished, he continued his services without a salary. Fortunately for Queensland, this act of unselfish devotion morally obliged the Government to reinstate him in his former position, which he now held without interruption to his end. He was elected a Fellow on the 4th April, 1878. [O. S.]

Richard Manliffe Barrington, M.A., LL.B., M.R.I.A., who had been a Fellow of this Society since the 5th April, 1883, was removed from its roll by his sudden and unexpected death on September 15th, 1915, at the comparatively early age of 66. He was born on May 22nd, 1849, at Fassaroe, near Bray, in County Wicklow, where his father, Edward Barrington, owned an extensive farm. From childhood in intimate touch with nature, and helped by the sympathetic encouragement with which his early inclination towards observation of the surrounding animal and plant world met from relatives and friends, he developed early those powers which raised him to a prominent position among the naturalists of Ireland. Taught mainly at home, he entered Trinity College, Dublin, in 1866, graduating with honours as a Moderator in Experimental and Natural Science in 1870. In 1875 he was called to the Bar, but he dropped soon Law to take up land valuing, which was more attractive to him, and together with the management of the Fassaroe farm formed henceforth the main occupation of his life. Thereby he also gained that independence and leisure which was necessary for the indulgence in his passion for exploring and studying the natural history of Ireland, a passion which had seized him early and got a firm hold on him during his student days, mainly through his intimate association with A. G. More and other Irish naturalists. His excursions extended all over Ireland, from his home to the wild Island of Tory in the north-west and the equally inhospitable Blaskets in the south-west, to the waters of Lough Erne in Fermanagh and of Lough Ree in

the centre of Ireland, the mountains of Sligo and Leitrim, and the hills of Tyrone. Occasionally he ventured far beyond his native island, visiting Iceland (1881), St. Kilda (1883), the Rocky Mountains (1884), North Rona (1886), the Shetlands (1890), and the lonely cliff of Rockall (1896). His fine physique and great endurance stood him in good stead on those journeys, which frequently involved hard walking and very rough quarters, and they also account for his remarkable feats as a climber in the Swiss Alps, where in 1876 he ascended within eleven days the Schreckhorn, Finsteraarhorn, Jungfrau, and Matterhorn and the intervening high passes.

Most of his zoological reports appeared in the 'Zoologist,' whilst his botanical articles found always a welcome place in the 'Journal of Botany.' His contributions to the 'Zoologist' began as early as 1866 with a note on the food of the wood-pigeon, whilst his earliest botanical observations were incorporated in the "Recent Additions" to 'Cybele Hibernica' (1872). The migration of birds in Ireland had early attracted his attention, an article on "Summer Migrants, co. Wicklow," in the 'Zoologist,' dating back as far as 1867. To extend his sources of information he put himself in 1882 into communication with the lighthouse keepers on the Irish coasts, and this he kept up with increasing success for many years. The results of his labours were laid down in the Reports of the British Association's Migration Committee for the Irish Section, for which he and More were responsible, and up to 1898, in his book 'The Migration of Birds,' which was published in London and Dublin in 1900. His last contribution to the ornis of Ireland was on the "Nest Material used by Blackcap," in 'British Birds' in the year of his death. For his numerous smaller articles and notes the list of his scientific writings by C. B. Moffat in the 'Irish Naturalist' for 1915 may be consulted. To those who knew him personally his loss came as a sad blow. "Barrington," writes R. Lloyd Praeger, in the 'Journal of Botany,' 1915, p. 366, "was a singularly lovable man. His hearty friendliness, his sense of humour, and a charming modesty which characterized all his intercourse, combined with a boyish enthusiasm which time did not impair, made his presence welcome and stimulating everywhere, and brought him a host of friends. [O. S.]

The death of Dr. Henry Charlton Bastian on the 17th November, 1915, at his residence Fairfield, at Chesham Bois, Bucks, removes from our List one of the seniors, he having been elected as far back as the 7th May, 1863. He was born at Truro on 26th April, 1837, and received his academic degrees of M.A. in 1861, and M.D. in 1866 at the University of London. 'The Flora of Falmouth and surrounding parishes' appeared as a paper of 30 pages in the volume of the Cornwall Polytechnic Society for 1856, a list compiled before he had reached his twentieth year. In the year of his election as Fellow, his paper on the

"Dracunculus or Guinea-worm" was published in our 'Transactions,' and two years later, his "Monograph on Anguillulidæ" appeared in the same series. Shortly before Dr. Bastian's death, the writer happened to congratulate him on the continued appreciation of his "Monograph," as shown by the demand for it, but found it jarred upon the author, for, as he said, he produced that when he 'was a callow student,' but the works of his maturer years were neglected or derided.

In 1867 he became Professor of Pathology in University College, Gower Street, and Assistant Physician to University College Hospital, becoming later full Physician, retiring in 1897. In 1868 he became associated with the Hospital for the Paralysed and Epileptic in Queen Square, retaining that connection till 1912. His professional career was that of neurologist, and during the middle portion of his life he was absorbed in that study, on which he published many works of great value. In 1872 he had produced a work in two volumes entitled 'The Beginnings of Life,' in which he maintained that life arose in sterilized flasks containing nutrient solutions. These volumes were reviewed by Dr. A. R. Wallace in 'Nature' and led to a long controversy in which Huxley, Burdon Sanderson and others took part. During the last few years he resumed the study of these phenomena, and brought out several small volumes, maintaining his doctrine, which were illustrated by half-tone blocks from his own photographs of his flask-cultures.

The following paragraph admirably sums up the facts:—"Bastian's views were not accepted by the scientific world. Still, his experiments showed that some scientific beliefs of his adversaries were not true; it was claimed that boiling would kill all germs, and that if organisms appeared in Bastian's flasks after boiling, it was due to faulty methods of technique; but it was subsequently found by Pasteur that desiccated germs in the form of spores could resist boiling. Moreover, Bastian showed that germs can exist in the living body, which we now know to be true; although the inference that they arose by spontaneous generation or by heterogenesis is both unnecessary and unlikely. Dr. Bastian always, however, held an impregnable position when he maintained that living matter must at one time have originated on the earth from non-living matter, and there is no logical reason why this process should not be continuing." (Proc. R. Soc. B. **89**. p. xxii.)

Dr. Bastian was elected a Fellow of the Royal Society so far back as 1868; in June 1915, he was awarded a Civil List Pension for his eminent services to medical science. [B. D. J.]

Henry Eeles Dresser came of an old Yorkshire family settled in the North Riding for nearly three centuries, and was born on May 9th, 1838, at the Thirsk Bank, of which his grandfather was the founder. His father, being a younger son, commenced life in London as a Baltic timber merchant, and this led to

Henry Dresser being sent to school near London, whence in 1852 he proceeded to a German school near Hamburg, and two years later to Gefle and Upsala to learn Swedish; it being considered that his acquirement of German and Swedish would be of great service to him in the prosecution of his father's business.

In 1856 he went to St. Petersburg, and thence to Finland, where he entered the office of a timber merchant. In 1857 he travelled through Finland on business, then through Sweden, and in 1858 all round the Baltic. In 1859 he went to New Brunswick as temporary assistant manager on a timber estate, returning in the latter part of 1860. In the two following years he travelled in Sweden, Finland, Russia, and Prussia, and in 1862 again went out to New Brunswick as manager of the timber estate for a year. Early in 1863 he took a cargo out to the Confederate States, remaining there for eighteen months.

From 1864 to 1870, when he engaged in the iron trade with offices in London at 110 Cannon-street, he travelled abroad every year, and visited Spain twice, Russia three times, Turkey, Austria, Italy, Servia, Bulgaria, and Roumania.

These extensive wanderings, combined with a knowledge of several languages, proved of immense service to him in the prosecution of ornithology. It enabled him to visit the principal museums of the Continent, and to make the personal acquaintance of many of the leading naturalists of Europe, with whom he was thus brought into direct communication, and also to become familiar with the foreign literature of his subject, and to translate for the benefit of English readers important articles that would otherwise have been unknown to them.

One of the earliest of these translations was an article in Swedish by Professor W. Meves, of Stockholm, "On the Change of Colour in Birds, through and irrespective of moulting." This was published with two coloured plates in 'The Zoologist' for March 1879.

In after years he supplied other useful translations of articles by Russian naturalists and explorers on ornithological discoveries of interest. This acquaintance with Continental literature and correspondence with leading writers on the subject, provided him with a mass of information of the greatest service to him in the preparation of his general work on the 'Birds of Europe.' It was planned in collaboration with the late Dr. R. B. Sharpe, and the first part was issued in their joint names in 1871. But soon afterwards, when Sharpe was appointed zoological assistant at the British Museum, his official duties prevented a continuation of his share in the work, which was then carried on by Dresser alone until its completion in 1881. It was a great undertaking, and a very costly one; the printing of eight thick quarto volumes and upwards of 600 hand-coloured plates necessitated an expenditure of several thousand pounds. But the result justified the cost, and Mr. Dresser not only lived to complete the

work, but to receive a universal acknowledgment of its value from naturalists in all parts of the world.

It was a great feat when in 1858 he discovered a breeding haunt of the Waxwing (*Ampelis garrulus*) on an island in the Baltic near Uleåborg, and had the peculiar satisfaction of taking a nest of this bird there with his own hands. This was two years after John Wolley had described for the first time the eggs of the Waxwing (until then unknown) taken at Sardio, Kemi Lappmark, in June 1856.

Since then he has made us acquainted with many rare eggs, the appearance of which was unknown until he described and figured them. Thus, in a series of articles on "Rare Palæarctic Birds' Eggs," published in 'The Ibis' from 1901 to 1906, he figured such rarities as the eggs of the white-tailed plover (*Chettusia leucura*), the pin-tailed snipe (*Gallinago stenura*), and of Ross's rosy gull, received from Mr. S. A. Buturlin, who discovered its nesting haunts in the delta of the Kolyma river, N.E. Siberia. The following year (Ibis, April 1907) he published descriptions and beautifully coloured figures of the eggs, previously unknown, of the Himalayan solitary snipe (*Gallinago solitaria*), which inhabits also the mountains of Northern Tibet, Mongolia and Siberia, and of the still rarer *Ibidorhynchus struthersii*, discovered by Mr. S. L. Whymper in the Himalayas, and figured for the first time.

In 1901–2, he had been experimenting upon the three-colour process for eggs with a view to the publication of a work on Palæarctic Oology, illustrated by that method. His first plate (Ibis, 1901, pl. 9) was executed by this process from a water-colour drawing, but in the next (Ibis, 1902, pl. 6) the figures were photographed in colours from the eggs direct, without the intervention of an artist, and were not touched by hand. This was the first illustration of birds' eggs illustrated by the new process. These experiments paved the way for the publication of his important quarto work, 'The Eggs of the Birds of Europe,' and furnishes a splendid complement to the previously published eight volumes (1871–81), with supplement (1895–96), of his monumental work on European birds.

Notwithstanding the labour entailed in the preparation and publication of these volumes, Mr. Dresser found time to bring out two important monographs: one on the Bee-eaters (1884–86), the other on the Rollers (1893), and both illustrated with beautifully coloured plates. The brilliant colours of the birds which compose these families makes these quarto volumes supremely attractive. The last work of importance which emanated from his busy pen was 'A Manual of Palæarctic Birds,' which was published in large octavo, without plates (1902–03). In view of the costly nature of the larger work in nine quarto volumes, which exceeds £50, these two octavo volumes came as a boon to those unable to afford the quarto, for

besides giving the synonymy, with descriptions of the plumages of both sexes, the habitat, and useful notes on all species recognised as European, it has the advantage of comprising also the latest views of the author on the general subject, and especially on classification and nomenclature.

In the course of years he accumulated a very large collection of both birds and eggs, the former amounting to nearly 12,000 specimens, and all of these, together with his entire library of ornithological works, are now in the possession of the Manchester Museum.

He was elected a Fellow of this Society 4th November, 1880, and served on the Council from 1883 to 1884. He died suddenly of heart-failure at the Villa Marie Louise, Cannes, on the 28th November, 1915, aged 77.

By the death of Professor David Thomas Gwynne-Vaughan, which took place at Reading on September 4th, 1915, the Linnean Society has lost a Fellow of high scientific standing, and one who might reasonably have been expected to render to it long and distinguished services. It was only in recent years that residence in or near London made it possible for him to take part in the business of the Society, though he contributed to its 'Transactions' so long ago as 1897, and was elected Fellow in 1907.

He was born on March 12th, 1871, at Royston House, Llandovery, being the elder son of Henry Thomas Gwynne-Vaughan of Cynghordy, later of Erwood Hall, Breconshire. His mother was Elizabeth, second daughter of David Thomas, of Royston House, Llandovery. She died in 1874, and Professor Gwynne-Vaughan was her only child. He went to school at Monmouth in 1882, and proceeded with an exhibition from school to Christ's College, Cambridge, where in 1891 he was elected to a scholarship in Science. In 1893 he took a First Class in the Natural Sciences Tripos, and left Cambridge to take up a Mastership. This, however, he soon relinquished in order to enter on research. With this object he went to Kew, and was admitted to the Jodrell Laboratory within the Royal Gardens.

This move was the determining point of his career. For the Laboratory was then under the direction of Dr. D. H. Scott, who soon recognised the qualities which had passed unnoticed among the crowd of undergraduates at Cambridge. Wittingly, or unwittingly, Gwynne-Vaughan had come under the influence of the very investigator by whom his patient and acute powers of observation could best be directed into that channel of anatomical enquiry, which he subsequently did so much to advance. Stelar problems were in their infancy in 1895. Van Tieghem had broken fresh ground, and had provided a terminology which was in advance of the observed facts. What was then urgently required was cool and controlled observation: and this was exactly what Gwynne-Vaughan was so well fitted to supply.

He first engaged in the examination of the stelar conditions

seen in the Nymphæaceæ, and the Primulaceæ: and the results were published in 1897; the former in a memoir in the 'Transactions' of this Society ("On the Morphology and Anatomy of the Nymphæaceæ"), the latter in the 'Annals of Botany' ("On Polystely in the genus *Primula*"). At the British Association Meeting at Liverpool in 1896 he gave a preliminary account of his observations, which showed his hearers that not only a new investigator, but also a new teacher had appeared. It led to his appointment as Assistant in the Botanical Department of Glasgow University. Lang was already a member of the staff there, and for ten years these two, with the Professor, worked together, each in his several way but with full mutual knowledge, upon problems relating to the Pteridophyta.

The anatomical experience of Gwynne-Vaughan, and his grasp of stelar questions as illustrated in flowering plants, fitted him to enter with special insight into the investigation of the anatomy of the Filicales. Mr. Boodle was already engaged at Kew in similar work. But by mutual consent it was arranged that while he undertook more especially the Schizæaceæ, Gleicheniaceæ, and Hymenophyllaceæ, Gwynne-Vaughan should devote himself to types which showed greater advance in anatomical complexity. Accepting the protostelic state as probably the primitive condition for all, it became necessary by patient observation and comparison to relate to it the more complex states already recognised by Van Tieghem as "polystelic." Gwynne-Vaughan approached this naturally through those types with a tubular stele in the axis, which he designated "solenostelic," reviving a term already introduced by Van Tieghem. A careful analysis of the anatomy of *Loxsoma*, as a typical example of this structure, was followed by comparisons with numerous other genera, such as *Hypolepis*, *Dennstædtia*, and *Pteris*. The gradual steps to dictyostely were thus traced, and the demonstration given that not only by comparison, but also in the individual life (e. g. *Alsophila*), the transition depends upon the overlapping of the foliar gaps in an abbreviated axis. The facts were embodied in two papers entitled "Observations on the Anatomy of Solenostelic Ferns," published in the 'Annals of Botany,' 1901, 1903. These contain a great body of condensed comparative observation, showing that solenostely and dictyostely are related conditions. The origin of medullary vascular tracts within the solenostele was also traced from their simplest beginnings.

But still there remained the more difficult question how the solenostelic state itself was related to the protostelic. Towards the solution of this problem, resort was made to comparison of certain fossils related to the living Osmundaceæ. The work was carried out in happy co-operation with Dr. Robert Kidston, F.R.S., of Stirling. This co-operation was real and equivalent. The one partner brought to bear on the problem a wide knowledge of fossils from the stratigraphical point of view; and he had already taken up a cognate enquiry in the Sigillarias. The

other supplied critical and expert anatomical experience based upon the study of living plants. The result is a series of beautifully illustrated Memoirs published by the Royal Society of Edinburgh ("On the Fossil Osmundaceæ," Trans. Roy. Soc. Edin. 1907, 1908, 1909, 1910, 1914). The fossil material was of world-wide origin, but chiefly from New Zealand, and from Russia. In a sequence of plants, dating from the Permian Period to the present day, and shown to be really related to one another by many structural similarities, an anatomical progression was traced which follows most convincingly the successive stratigraphical horizons. It illustrates steps in the medullation of the stele, and in the amplification of the leaf-trace, and it throws light upon the probable origin of the leaf-gap. Some still hesitate in full acceptance of the far-reaching conclusions which were drawn; but in most quarters the Memoirs of this magnificent series are held as botanical classics; and none can be blind to the validity of the methods, or the acuteness of the internal criticism which they show. Though the details of the progression from the protostele to the confirmed solenostele are not fully demonstrated in them, the foundations are securely laid, and others are already building upon them.

In relation to this work on the Fossil Osmundaceæ there was also published a short but important joint note "On the origin of the adaxially-curved leaf-trace in the Filicales" (Proc. Roy. Soc. Edin. 1908, p. 433). There are also two later papers by Gwynne-Vaughan alone. The first of these, entitled "Some remarks on the Anatomy of the Osmundaceæ" (Ann. of Bot. July 1911), dealt with the structure of the young plant, and the origin of the medullation, and of the foliar gaps in the individual life. The second was his last completed work, and it described a case of "mixed pith" found by Mrs. Gwynne-Vaughan in an anomalous specimen of *Osmunda regalis*. The structure seen in it was held to support the theory that the pith of the Osmundaceæ is phylogenetically stelar, and not cortical.

The two series of Memoirs above mentioned embody the most effective work of Gwynne-Vaughan. But they by no means exhaust it. He originated a most ingenious theory of the stele of *Equisetum* (Ann. of Bot. 1901): he discovered the axillary buds of *Helminthostachys* (Ann. of Bot. 1902): he worked through the anatomy of *Archangiopteris* (Ann. of Bot. 1905). He also wrote on the curious lattice-work structure of certain Fern stems (Ann. of Bot. 1905), and on the minute structure of the tracheæ of Ferns (Ann. of Bot. 1908). In all of these his originality was patent, though restrained. He had also entered upon other work in co-operation with Dr. Kidston. A memoir on *Tempskya* was published in Russia (Verh. d. Russ. Kaiserl. Mineral. Gesellschaft, Bd. xlviii. 1911), and a new series "On the Carboniferous Flora of Berwickshire" had been opened with its "Part I. *Stenomyelon*" (Trans. Roy. Soc. Edin. 1912). But here the curtain falls prematurely upon a life of investigation full of promise, as in the

past it had been remarkably full of achievement. Only 44 years of age, we can hardly forecast what Gwynne-Vaughan might yet have done if he had lived out the full span.

But he was not merely a laboratory Botanist. He had an acute sense of specific characters, and a good knowledge of the native Flora in the field. His systematic analysis of difficult species of Algæ was pertinacious and successful. And equally in the determination of Ferns, his systematic powers were exercised upon the collection brought back by Professor Lang from a journey in the Eastern Tropics. He was also an extensive traveller himself. In 1897 he went up the Amazon and Purus rivers some 3500 miles, as botanist attached to a rubber-prospecting expedition; but his scientific proclivities were restricted by the jealous demands of the firm that employed him. In 1899 he joined the Skeat Expedition to the Malay Peninsula, and experienced the delights of forest life with attendant Malays, on the borders of Siam. But perhaps owing to his own delicate sense of duty to the expedition he was with, he made no private collection for the purpose of future work. It is, however, an interesting fact that some of the plants which he collected for the Skeat Expedition were among the last of the new species determined by the veteran, Sir Joseph Hooker. In 1909 he attended the British Association Meeting at Winnipeg, making the acquaintance of Canadian Forests and Lakes. Thus as a traveller he had touched three of the great geographical areas of the world.

We have traced Gwynne-Vaughan to Glasgow, where he worked from 1896 to 1907, as assistant, and later as Lecturer in Queen Margaret College. In 1902 he co-operated with Professor Bower in producing the Second Edition of "Practical Botany for Beginners" (Macmillan & Co.), which has gone through several reprints. In 1907 he was appointed head of the Botanical Department at Birkbeck College, London, and for two years he toiled in formulating elementary and advanced lectures covering the whole area of the Science. In 1909 he received the appointment of Professor in Queen's University, Belfast. In 1911 he married Dr. H. C. I. Fraser, herself an accomplished Botanist, who had succeeded him in the post at Birkbeck College. He was finally transferred from Belfast in 1914 to the Chair of Botany in University College, Reading But he lived only to complete one full year of duty there. His health had latterly not been good, though he bravely continued his work to the end. He may be said to have run in harness till within two months of his death.

His appreciation among Botanists has been quite general. All felt the sincerity, the acuteness, the scrupulous care that characterised his work. An outspoken critic, he was always ready to help with suggestions and with facts, of which he had an uncommon store laid by in very carefully tabulated notes. He became personally known to the general body of British Botanists

by holding office first as Secretary (1901, 1909-11), and later as Recorder (1912-13) of Section K of the British Association. Not only was the business of the Section well conducted by him, but he had the power of keeping the body of botanists together in friendly relations. They will feel that by the death of Gwynne-Vaughan they have lost not only a prominent investigator, but also a colleague who had a happy power of promoting unity and co-operation.

Already distinctions had come his way. He was elected to this Society in 1907. In 1910 the Royal Society of Edinburgh awarded to him the MakDougall-Brisbane Medal, for his researches published in the Society's 'Transactions': and in the following year he was elected a Fellow. In 1912 he was elected M.R.I.A. His friends anticipated for him at an early date further, and even higher distinctions. But such honours are only the ostensible signs of appreciation currently given by contemporaries. The work of Gwynne-Vaughan is of a nature that will ensure its permanence: and that is the mark of real distinction. His results were always strictly tested, and criticised before publication. The consequence is that they will be durable, and take permanent place in the web of Botanical Science.

Personally Gwynne-Vaughan was of light build. At Cambridge he rowed, and played Rugby football. In later years cycling and fishing were among his amusements. But as the interest of his scientific work gripped him, he sacrificed more and more of the time available for exercise to his laboratory. A prominent characteristic was his dry humour, which was combined with an almost whimsical expression of it. Through this shone constantly the steadfast scientific ideal. As a colleague he was always loyal and helpful. Private and personal interests were wholly effaced by the dominating sense of duty, and of camaraderie. Such factors made up a personality as attractive and refreshing as it was original. He was one different from the common run of scientific men; and it is the unique personality that we miss most when it is gone. [F. O. Bower.]

Ernest Lee, who lost his life in the trenches in Flanders, on the 10th July, 1915, was born at Stanley Cross End, Yorkshire, on the 11th April, 1886, and he was therefore only in his thirtieth year when his life ended.

His parents removed during his early childhood to Burnley, and there he attended the evening classes at the Technical Institute. He acquired a deep interest in Natural Science, and succeeded in attaining a National Scholarship in Geology in 1906. This brought him to the Royal College of Science, London, where he was successful in gaining the Edward Forbes Medal and Prize in Botany, and a Marshall Scholarship. The latter enabled him to spend another year in the Royal College, which he turned to account in his investigation on the morphology of Leaf-fall (Ann. Bot. xxv. 1911, pp. 51–106, pls. 4–6).

In 1910 he became Demonstrator and afterwards Assistant Lecturer in Botany at Birkbeck College, London, and three years later he migrated to the Department of Agricultural Botany in the University of Leeds. The following year, 1914, he married Miss H. S. Chambers, F.L.S. Whilst at Leeds he had joined the Officers' Training Corps, and in September 1914 was gazetted second Lieutenant in the 4th Duke of Wellington's (West Riding) Regiment. He became machine-gun officer, then lieutenant, and was sent to the Front, three months before he fell.

He was elected Fellow on the 1st June, 1911. Besides the paper on Leaf-fall above mentioned, he was the author of two papers on seedling anatomy (Ann. Bot. xxvi. (1912) pp. 727–746. t. 68; *ib.* xxviii. (1914) pp. 303–329). [B. D. J.]

Robert Heath Lock died at Eastbourne, on the 2nd June, 1915, unexpectedly, having gone to that place for a short holiday.

He was born at Eton College in 1879, his father, the Rev. John Bascombe Lock, being then an Assistant Master there. He was educated at the Perse School, Cambridge, Mr. Stone's school at Broadstairs, and Charterhouse, where he became head monitor of Hodgsonites.

He went up to Caius College, Cambridge, as an Exhibitioner for Natural Science in 1898, took a first class in the 1st part of the Natural Sciences Tripos in 1900, and a Scholar of his College, and a 1st Class in Part II. (Botany) in 1902. Upon being elected Frank Smart Student he went to Ceylon and worked for two years at various subjects of research, especially the cross-breeding of Maize, under Dr. J. C. Willis, F.L.S., at Peradeniya. As a result he was elected a Fellow of his College, and returned to Cambridge, and spent the next four years in the Botanical Laboratory, on material brought back from Ceylon, and on his book 'Variation, Heredity, and Evolution,' published by Murray in 1906.

In 1908 he returned to Ceylon on the invitation of Dr. Willis as Assistant Director of the Peradeniya Gardens, a post specially created for him. He held the office till 1912, having come home on leave in 1910 to be married, and took the degree of Sc.D. During these four years he continued his researches on plant-breeding, and as one result, produced a new strain of rice, now known as Lock's Paddy, which is displacing other varieties in the island.

Meanwhile changes took place in the administrative circles; the government had decided to create a Department of Agriculture and put the Director of the Peradeniya Gardens under the Director of Agriculture, and the Garden post was offered to Dr. Lock. He found himself unable to accept it, and returned to Cambridge, wrote a small book on rubber for the University Press, and then became an Inspector under the Board of Agriculture and Fisheries, in charge of the district round Birmingham, including the fruit and hop-growing districts in Worcestershire and Herefordshire.

Upon the war breaking out, Dr. Lock was requested to organize experiments on the drying of fruit and vegetables, so as to increase the national supply of perishable foodstuffs. He threw himself with characteristic energy into his work, and nothwithstanding medical orders to the contrary, continued to push the work of his Committee during two severe attacks of influenza in February and March, 1915. Even after this he refused to take a holiday, and his premature death must be ascribed to the injury thus caused to his nervous system. At the time of his death he was nominated the British Representative at Rome on the Council of the International Agricultural Institute.

Thus passed away at the early age of 36, a life which promised great results. Dr. Lock was elected a Fellow of the Linnean Society, 2nd May, 1912. [B. D. J.]

Edward Alfred Minchin, M.A., Ph.D., F.R.S.—"It is sad to know that such a lovable man, representing the highest type of scientific worker, remains with us now only as a memory. It is rarely that a scientific man is held by every one of his colleagues and contemporaries in such esteem as Minchin has been." These words in a letter of Prof. R. A. Gregory to the present writer, after the passing of Prof. Edward A. Minchin, represent and reflect the rarely felt grief with which the scientific world learned of his death, which took place at Selsey Bill, in Sussex, on the 30th September, 1915.

Born in 1866, the son of Charles N. Minchin by Mary J. Lugard his wife, Minchin may be said to have been prematurely cut down in the full meridian of his life's work. That his end was hastened by a constitutional weakness which had afflicted him from his birth there can be no doubt; indeed, it was a marvel to his family that he ever reached adolescence, but to the last day of his life, as the writer, who was with him to the end, can testify, his brain never showed the faintest sign of weariness, and his clear critical faculty and cultured turn of phrase and epigram never weakened. Two days before his death, in reply to a quotation from Oliver Wendell Holmes, "Life, as we call it, is nothing but the edge of the boundless ocean of existence where it comes on soundings," he said, in one of those quiet flashes which made him such a delightful companion, "And Death, as we call it, is nothing but the unfathomed deep of the ocean of existence where we lose the sounding apparatus—bottles, thermometers and all!"

We take the historical stages of his career from the admirable and sympathetic obituary notice contributed by Mr. E. S. Goodrich to 'Nature' (7th October, 1915). He was educated at first privately, on account of his extreme delicacy, and was for a short time at the United Service College at Westward Ho! Having joined his parents, who were then resident in India, at the age of fourteen he was at the Bishop Cotton School in Bangalore,

and here were laid the foundations of his scientific career, his early collections and his almost precocious observations on the animals and birds of India, remaining fresh in his remarkable memory and contributing not a little to the success and completeness of his later work. He took an Exhibition at Keble College, Oxford, and though a finished and keen classical scholar, he took a science degree with honours in zoology in 1890. He was awarded the University Scholarship at Naples, and afterwards the Radcliffe Fellowship. The beauty and perfection of his cytological microscopic preparations were always remarkable, and whilst at Naples he prepared a most wonderful series of slides showing the development and cell-division of the blastoderm of the cuttlefish. These researches he never published, as he immediately turned his attention to the Spongiadæ and the mode of formation of sponge-spicules, publishing the results of his observations in many papers of the highest scientific value, over a long period. In 1893 he became a Fellow of Merton College, and spent many years visiting the Marine Biological Stations at Plymouth, Roscoff, Banyuls, and Naples, and working in the laboratories of Prof. Bütschli (at Heidelberg), whose work on Protoplasm and Microscopic Forms he translated (London 1894, Black), and of Prof. R. Hertwig (in Munich). He was assistant to Sir E. Ray Lankester and Demonstrator in Comparative Anatomy at Oxford for some years before he became lecturer in biology at Guy's Hospital, which post he held for a short time before succeeding Weldon as Jodrell Professor of Zoology at University College, London, in 1899. Seven years later the Chair of Protozoology was founded in the University of London, Minchin was called to fill the post of Professor, and assumed the direction of the new department of Protozoology at the Lister Institute of Preventive Medicine at Chelsea, where, as Prof. Goodrich has said, "he pursued his researches with untiring industry, and reached those brilliant results which have made his name famous among protozoologists the world over." He married in 1903 Miss Florence Maud Fontain, who survives him. In 1910 he was awarded the Trail Medal of our Society, and in 1911 became a Fellow of the Royal Society.

His first scientific paper "On a new organ in *Periplaneta*" (Q. J. Micr. Sci. vol. xxix. 1888) and a short note on the embryo of *Aurelia* (Proc. Zool. Soc. 1889) were published before he took his degree, and shortly after he gave an account of the Cuvierian organs of the Holothuridæ. Wide as was his general zoological knowledge (he was a Vice-President of the Zoological Society, and at the time of his death Zoological Secretary of the Linnean Society) he specialized in the Porifera and the Protozoa, on which he contributed many articles and papers, to the 'Encyclopædia Britannica,' to Sir Ray Lankester's 'Treatise on Zoology,' and elsewhere, whilst his last published book 'An Introduction to the Study of the Protozoa' (London 1912, Arnold) is, as Prof. Goodrich has said, "by far the best text-book yet written on the

subject in English, or perhaps in any language, and will long remain a standard work." It is a remarkable monument to the thoroughness of Minchin's work; the Bibliographies to each chapter which supplement the voluminous references in the foot-notes, may be said to constitute a select Bibliography of the whole subject, whilst the Index (of which he was always proud) made the work practically encyclopædic. Continually in correspondence with protozoologists all over the world, he amassed a very remarkable collection of books and papers upon the Protozoa, and we are happy in being able to record that the Governing Body of the Lister Institute purchased the entire collection after his death for a sum generously calculated to prove of material advantage to his widow. He was, it need hardly be said, an accomplished linguist, and his tri-lingual speeches at Meetings of the British Association may be described as linguistic feats.

His papers on the structure, development, and classification of the Calcareous Sponges were principally published between 1892 and 1898, though many later papers give the results of his further observations. These observations he made invariably upon the living animal, and he has often told the writer of his experiences as a diver—in which art he was extraordinarily expert—collecting his specimens himself, by hand, from the sea-bottom, and noting their habits of growth and associations, clinging to a rock under water until compelled to return to the surface. "These studies culminated in a masterly and beautifully illustrated memoir on the development of the spicules of the Clathrinidæ (Q. J. Micr. Sci. vol. xl.), a triumph of technical skill over the difficulties encountered in dealing with minute histological details. .... His mastery of technique was indeed remarkable, and great was his ingenuity in devising improvements in the instruments used and routine followed in his investigations." The present writer possesses what are probably the last highly technical preparations made by Minchin—a series of sections of a debatable organism allied to the Foraminifera, in the determination of which Minchin was still keenly interested during his last days at Selsey. These preparations, though made in an interval of his last and fatal illness, are no whit inferior to the sections that he made at the time when his health was—for him—robust.

In 1905 he was in Uganda working upon the Royal Society's Sleeping Sickness Commission, and from that time until his death he devoted all the time that could be spared from his professorial duties to working at the life-histories of the Trypanosomes. His last great work was his Monograph, written in collaboration with Mr. J. D. Thomson, on the Trypanosomes of the Rat-flea. "Some idea of the magnitude of the work may be gathered from the fact that more than sixteen hundred fleas were examined and dissected in the course of these researches." The results were published in the Q. J. Micr. Sci. (vol. lx.) only a few months before his death. Of this work Sir E. Ray Lankester in a letter to the present writer says:—"It is one of the most thorough and

careful pieces of work ever produced by a British microscopist. It is the result of several years of study and experiment, and represents many hundred hours of microscopic observation, and record by drawing and note. It establishes in the most minute detail the life-history of the rat's Trypanosoma, both in the rat and in the associated host—the rat's flea. Our dear friend was hard at work breeding both flea and Trypanosome whilst already suffering from the affection of the heart which ended his life. When he finished his bulky paper and mass of illustrations and sent them to me for publication, he wrote: 'Many men have broken their hearts for a woman, but I shall be known as the man who broke his heart for a flea!'"

A feature of Minchin's work which will always stand out in scientific literature was the ease, lucidity and grace of his literary style. His Presidential Addresses during the years that he was President of the Quekett Microscopical Club present this feature in a very marked degree, and especially was it noticeable in his Presidential Address to Section D (Zoology) of the British Association at Manchester, in September 1915, entitled "The Evolution of the Cell." This Address was written in a comparatively easy interval of his last illness—he spoke of it aptly as "his swan-song"—and into it he put all the ideas which had been maturing for years in his mind, and which he had hoped to elaborate in a volume. He knew that he would not live to complete that volume, though outwardly he was hopeful to the last and full of plans for the future. It was thus that the Address, as written, was of a length hitherto untouched by any Sectional Address ever delivered. It was the mournful privilege of the present writer to correct the proofs whilst Minchin was spending the last week of his life with him at Selsey, and to read a full abstract of it at Manchester, at the opening meeting of the Section. The effect produced by that address, and the judgments formed upon it in its extended and published form are still matters of yesterday—the bold assumption and treatment of the single cell as a completely evolved organism, may be fearlessly described as a new concrete basis for the study of cytology, originating in his startling aphorism of the first appearance of "the brand of Cain" in the biococci, "a class of organism which was no longer able to build up its substance from inorganic materials in the former peaceful manner, but which nourished itself by capturing, devouring, and digesting other living organisms."

It was clear to the seeing eye, and the present writer was so apprized by Minchin's physician, that when we put him into our car at Chelsea and took him easily and quietly down to the sea, "the great sweet mother" whom he had always passionately loved, that no return thence was to be humanly expected for him. The days and weeks that passed in the companionship of his devoted wife, and devoted friends, saw him growing hourly weaker in body, though his mind retained its old activity, and he never wearied of teaching the children to observe the flowers, the birds and insects,

or of answering the stream of questions with which they assailed "the Professor" whenever he was in sight.

The end came rather suddenly, after two days of comparative vigour and hope—to the last he was bright, courteous, and considerate—he died as he had lived, a witty and charming gentleman, and a Crichton of the Scientific World.

[Edward Heron-Allen.]

Hermann Graf zu Solms-Laubach, D.Ph. (Berlin), D.Sc. (Cambridge), F.M.R.S., late Professor of Botany in the University of Strassburg-i.-E., and a Foreign Member of this Society since 5th May, 1887, died in Strassburg on November 24th, 1915. By descent he belonged to one of the oldest families of the German nobility, which was variously connected with some of the reigning houses of the German Empire, and itself lost its sovereignty only as late as 1806, when it shared the fate of "mediatisation" with many other small dynasties. He was born at Laubach in Oberhessen on December 23rd, 1842, as the son of Count Otto zu Solms and Countess Luitgard, a princess of Wied by birth. He received his early education at his father's house, at Schnepfenthal (1854–1857), then a famous grammar-school, and at Giessen, where he entered the University in 1861. Although he stayed there only one "semester," it was there where he made up his mind to devote himself to the study of natural history and especially of botany, in which choice he was probably influenced by the interest which his brother Friedrich and his uncle Reinhard took in botany, the former as mycologist, the latter as bryologist. From Giessen he went, in 1862, to Berlin, where Alexander Braun's name attracted so many botanical students. Here he received, in 1865, the degree of a Doctor Philosophiæ, his dissertation being "De Lathrææ generis positione systematica." In the following year he went to Portugal, where he explored more particularly the moss flora of the province of Algarve. From this journey resulted a paper in Latin, "Tentamen bryo-geographiæ Algarviæ, regni Lusitani provinciæ" (Halle, 1868), which served him as "Habilitationsschrift," and thus opened to him the door for an academic career. He had, during his university studies, become acquainted with De Bary, then Professor of Botany at Freiburg in Baden, and actually spent one "semester" with him. He followed him now to Halle, where De Bary had meanwhile founded a botanical laboratory and established himself as Privat Dozent in the university of that town. His association with De Bary was decisive not only for his academic career, but also for much of the spirit in which his work was carried out; for, as Jost says of him, he was by his own genius essentially an artist who conceived intuitively and saw in the first place through his imagination; but whatever the flights might be to which his mind was led in that way, he always knew how to bridle himself, and that he had learned in De Bary's school. A certain heaviness in his style, which makes much of his writing not easy reading,

may be traceable to this severe imposition of self-criticism and a burning desire for exactness and thoroughness. Four years later he went as Professor extraordinarius to Strassburg, where De Bary had been appointed as Professor of Botany in the new Imperial University. From 1879 to the end of 1887 he taught botany at Göttingen, where he succeeded Grisebach. After Eichler's death, he was invited to take the chair of botany in the University of Berlin. He accepted, though with great reluctance; but before he entered on his new duties De Bary died, and, asked to take over his professorship, he decided for Strassburg, at which university he lectured and worked until increasing infirmity obliged him to retire in 1908. He continued, however, to live in the city which had become dear to him, and gave whatever time he could save from the struggle with his insidious malady to the pursuit of his studies, his latest printed contribution dating from the year before his death.

There is no doubt that botany has lost in Solms-Laubach, if not one of its greatest, certainly one of its most original exponents. So great was his universality and versatility of mind that it might appear difficult to class him among botanists, but Jost is probably right in putting him down in the first place as a systematist. As such, he showed a remarkably wide conception of his working field and method, introducing morphology and anatomy, and raising them above the mere formal element by linking them up wherever possible with biology. His first publication was a note on a parasite, *Orobanche Buekiana*, Koch, in Verh. Bot. Verein. Brandenburg (1863), and the next his dissertation on *Lathræa*, which has already been mentioned, and throughout his life his interest for parasites and saprophytes never left him, as his papers on the Rafflesiaceæ, Hydnoraceæ, Balanophoraceæ, Santalaceæ, Loranthaceæ, Lennoaceæ, Cuscutaceæ, Orobanchaceæ, and Rhinanthaceæ prove, and even one of his very last communications, in 1914, dealt with a parasite, the obscure genus *Sapria*, which was recognised by him as a close ally of *Rafflesia*. Some of the families mentioned were treated by him in monographs, namely, the Rafflesiaceæ, Hydnoraceæ, and Lennoaceæ, to which may be added, as other specimens of monographs by him, his treatises on the Caricaceæ, Pontederiaceæ, and Pandanaceæ. His other systematic papers of smaller compass are numerous, and concern the most varied groups among the phanerogams as well as the cryptogams. A perusal of the long list of his publications by Jost in 'Berichte der Deutschen Botanischen Gesellschaft,' vol. xxxiii. pp. 109–112, will give the reader an adequate idea of the width of ground which he covered. It may suffice here to emphasize his prominent share in algological work of the first order.

Next to systematic botany, his working field was in the department of phyto-palæontology. Here his 'Einleitung in die Palæophytologie,' Leipzig, 1887 (translated into English by H. E. F. Garnsey and revised by I. B. Balfour, 1891, published under the title 'Fossil Botany,' 1891), marks a turning-point in phyto-palæontology. The great success of the book and the still

active influence it has on the development of this particular branch of botany are due to the exact application of his experience as a great systematist of living plants to the fossil floras. To him, phyto-palæontology was essentially a division of systematic botany—a supplement from the past to our science of the living plant-world, viewed from the standpoint of the systematist. Here, too, many papers of smaller scope would have to be added if space permitted.

Another field in which he laboured with the most happy results is the history of our cultivated plants. His essays on the fig, the papaya, wheat, tulips, and strawberries belong to the best that has been written in this line. Here his wide reading and historical and philological knowledge stand him in good stead.

Further, reference has to be made to his book, 'Die leitenden Gesichtspunkte einer allgemeinen Pflanzengeographie,' Leipzig, 1905, in which his early interest in plant geography, which never quite flagged, revived and led to a treatment of the more biological and historical problems which is quite original. Unfortunately, it is heavier reading than anything else he has written, and has, perhaps on this account, not found the recognition which it deserves.

This short account of Solms-Laubach's achievements would not be complete without mentioning his share in the editing of the 'Botanische Zeitung,' for which De Bary had been responsible since 1872. When Solms-Laubach succeeded De Bary as Professor at Strassburg, in 1888, he also took over the editorship of the journal, first in conjunction with J. Wortmann (1888–1897), then with Professor F. Oltmanns. For twenty years it continued in its old time-honoured form; but when at last a concession to modern requirements appeared imperative, difficulties arose with the publishers which led to the withdrawal of the editors, who now (1908), joined by Prof. L. Jost, founded the 'Botanische Zeitschrift.' With it Solms-Laubach remained associated until his death.

Great as Solms-Laubach was as a man of science, he was as fine as a man among men. He added to the aristocracy of his birth the higher nobility of a truly noble mind. He was above all class spirit, warm-hearted and kind, a true friend of his friends —and there were many of them all over the world, and not the least in this country—unbound by conventions, always himself in carriage and dress, in language and gesture, whether serious or swayed by humour, always the one whole lovable man. [O. S.]

John Medley Wood, D.Sc., late Director of the Natal Herbarium, died at Durban, Natal, on August 26th, 1914. He was born at Mansfield, Nottinghamshire, on December 1st, 1827, as the son of a naval officer. He followed the career of his father, entering the East India Merchant Service, in which he rose to the rank of Chief Officer. In 1852, however, he went to Durban, where his father, who had meanwhile become a solicitor, practised. For many years he earned his living by trading and farming. A certain

inclination for botany, however, brought him into contact with the then Curator of the Botanic Garden at Durban, Mr. M. J. McKen, who afterwards married his sister. This association decided his further career. In 1882 he was appointed to the post which his brother-in-law had occupied. Subsequently he was made Director of the Gardens, but when eventually the Garden and the Herbarium were separated he retained the Directorship of the Herbarium, and that he held until he died. Long before his official connection with the Durban Garden he was active in collecting plants, of which he sent numerous specimens, dried and living, to Kew, a practice which he maintained up to the end of his life. His intimate knowledge of the flora of Natal is well reflected in his publications, among which his 'Natal Plants,' a work in six volumes with 600 plates, representing as many species, occupies the first place. Others are 'A Guide to the Trees and Shrubs of the Natal Garden,' a 'Handbook to the Flora of Natal,' and a 'Revised List of the Flora of Natal.' His undoubtedly great merits with regard to the botanical exploration of Natal found their recognition in his election as an Associate of the Society on May 5th, 1887, and the presentation of the degree of Doctor of Science to him by the University of the Cape of Good Hope. [O. S.]

Charles René Zeiller, Inspector General of Mines, Vice-President of the Council of Mines, and a Member of the Institut de France, was born at Nancy on January 14th, 1847 *. We are here interested in his work as a palæobotanist; he was scarcely less distinguished as a mining engineer.

Zeiller entered the École Polytechnique in 1867 and passed out in the First Class. He thereupon joined the Service of Mines, and was appointed Engineer in 1870. Thus his career opened at the time of the last great war; it terminated, by his death on November 27th, 1915, in the midst of the still greater conflict now raging. It is remarkable that he died within three days of his distinguished German fellow-worker Count Solms-Laubach, with whom he was on terms of friendship.

Zeiller took an active part in the war of 1870, serving as Lieutenant in a mining company attached to the Engineers; he was engaged in the defence of Paris, and it was his special work to establish underground communications between the city and the southern forts.

On the return of peace, he joined for a time the Secretariate of the Council General of Mines. Zeiller's scientific work, throughout life, was carried on in the midst of the most exacting professional duties. He became Secretary of the Annales des Mines in 1878, and of the Conseil Général ten years later, holding both these offices till 1910. In the following year he attained the high office

* The writer is indebted, for much information regarding Zeiller's career, to two obituary notices, by his colleagues, H. Douvillé and C. Walckenaer, in the Bull. Mens. de l'Assoc. Amicale des Elèves de l'École Nat. Sup. des Mines, Janvier 1916.

of Vice-President, and at the same time became President of the Central Commission on Steam-engines. In all his appointments he discharged his official functions with the utmost energy and success.

Zeiller had been interested in Botany as a young man, and while at the School of Mines paid special attention to the collections of fossil plants. Early in his career he began to be recognised as an authority on this subject; plants from the coal-beds of Chili were submitted to him, and he determined their age as Jurassic, contrary to the then prevalent belief that true coal could only occur in the Coal Measures. His investigations were in close touch with his official work, for he laid stress on the practical value of evidence from fossil plants in determining the relations of coal-seams.

In 1878 Zeiller contributed a description of the principal species of French Coal-Measure plants to the Explanation of the Geological Map of France. In the same year he began his admirable courses of lectures on Fossil Botany at the School of Mines, and took charge of the collections, which under his care came to be of inestimable value to palæobotanists. From this time onwards Zeiller's position as a leader in Fossil Botany was established; he produced, from year to year, a continuous series of important memoirs. The amount of scientific work which he was able to accomplish, side by side with his official duties, is remarkable; his energy was great, and it must further be remembered that his official position gave him access to a vast supply of material from all quarters. It must also be recognised that the authorities of his department took an enlightened view of the position and did all in their power to facilitate scientific research.

Only a few of Zeiller's works can be referred to here; we may begin with the great series of Fossil Floras. The first of these, that of Valenciennes *, is a magnificent work, of equal value to the geologist and the botanist. It gives an exhaustive account, beautifully illustrated, of the Flora of the most important Coal Field of France. The introductory chapters contain an admirable discussion of the fructification of Carboniferous Ferns, a subject on which Zeiller was perhaps the first authority. In fact the Ferns and fern-like plants had a peculiar attraction for him all through his career. Thus in the next important Flora, that of the Upper Coal Measures of Commentry in Central France (1888–1890) †, he undertook the part on the Ferns, Renault doing the other groups. So, too, in the famous Flora of the Permo-Carboniferous beds of Autun and Épinac (1890) ‡, it was Zeiller, again, who worked out the Ferns, or most of them, his colleague completing the Flora some years later. Zeiller's

* Études des Gîtes Minéraux de la France. Bassin Houiller de Valenciennes. Description de la Flore Fossile. Paris, 1886–8.

† Études sur le Terrain Houiller de Commentry. Flore Fossile. Part I. Bull. Soc. ind. min., 1888–90.

‡ Études des Gîtes Min. de la France. Bassin Houiller et Permien d'Autun et d'Épinac. Flore Fossile. Part I. Paris, 1890.

contribution is a masterly work, containing, among other things, a most accurate and elaborate investigation of the complex anatomy of *Psaronius*, and incidentally establishing, for the first time, the true nature of the Medullosean stem as a polystelic structure, comparable in its ground plan to the stem of the higher Ferns.

A couple of years later Zeiller published another French fossil Flora, that of the Permo-Carboniferous strata of Brive, in the Department of Corrèze*. In addition to the description and illustration of species, this volume contains valuable observations on the fructification of Ferns, in particular that of *Zygopteris*, affording an important extension of Renault's results.

After an interval of ten years yet another great Flora saw the light, belonging, this time, to a different period and a remote region. This is his work on the fossil plants of the coal-deposits of Tonkin, in French Indo-China†. Fully 30 years before, in 1882, Zeiller had determined the age of these beds as Rhætic; his final monograph is one of the most important contributions we possess to the Flora of this period, so interesting to the palæobotanist.

Returning to the fossil treasures of his own country, Zeiller published in 1906 his Permo-Carboniferous Flora of Blanzy and Creusot‡. This was the first important Flora to be published after the discovery of the Pteridosperms, and Zeiller had to face the difficulty of distinguishing between the members of the new group of Seed Plants and the true Ferns, which they so closely resemble. He wisely decided, on practical grounds, to keep the two classes together, for floristic purposes. Among the other plants described is that remarkable Lycopod *Selaginellites Suissei*, which might be interpreted as a primitive type of the Selaginellas. The difficulties involved in such a filiation are critically discussed.

Apart from the great Floras just enumerated, Zeiller wrote, at one time or another, on fossil plants from every part of the world. His work on the Flora of the Lower Gondwana appeared in 1902, under British auspices, in the 'Palæontologia Indica.'

The floristic work of Zeiller was in part of geological interest, and so far stood in close relation with his official duties as a mining engineer. At the same time he kept purely botanical questions equally in view, and the most acute and judicious treatment of points of affinity and morphology characterizes his systematic treatises. As fossil Floras they have certainly never been surpassed.

One of Zeiller's lines of work was the correlation of the Coal Measures of Northern France with those of Westphalia and the South of England. When the Kentish coal-borings were undertaken, it was naturally to Zeiller that the plants found were referred, and several papers on the subject were the result.

* Études des Gîtes Minéraux de la France. Bassin Houiller et Permien de Brive. Flore Fossile. Paris, 1892.

† Ibid. Colonies Françaises. Flore Fossile des Gîtes de Charbon de Tonkin. Paris, 1902–3.

‡ Ibid. Bassin Houiller et Permien de Blanzy et du Creusot. Flore Fossile. Paris, 1906.

Among discoveries of special botanical value, in addition to the important work on the fructification of fossil Ferns, already alluded to, may be mentioned Zeiller's discovery of the cones of *Sigillaria* (1884), which for the first time definitely proved the Cryptogamic nature of these plants and their close relationship to *Lepidodendron*. Not less important was his demonstration of the structure of the fructification of *Sphenophyllum* (1893), a remarkable example of the correlation of evidence from carbonaceous impressions with that from petrified specimens. The recognition of *Vertebraria* as the rhizome of *Glossopteris* (1896) is another of his botanical results. The mention of *Glossopteris* recalls his valuable essay on the differentiation of Botanical provinces at the close of the Palæozoic Period, a time when a clear distinction between a Northern and a Southern Flora manifested itself, while, both before and after, the vegetation of the world showed a remarkable uniformity.

The discovery that so many of the so-called Carboniferous Ferns were in reality seed-bearing plants (Pteridosperms) found a generous recognition from Zeiller, who was the first to bring the new results before the French Academy (1904). In a subsequent essay (1905)* he gave a critical account of the whole question, which is still the best we possess.

The fine monograph on the famous fossil *Lepidostrobus Brownii* (1911) † completely clears up the relationships of this fructification, of which Zeiller determined the Lower Carboniferous age.

As regards the broader questions involved in palæontological studies, Zeiller was a thorough evolutionist, but not a Darwinian, for he was a believer in abrupt changes (mutations or rather saltations) leading at once not merely from species to species but even from group to group ‡. Though, in the opinion of the writer, he went too far in this direction, Zeiller undoubtedly did good service to Science in dwelling on the immense difficulties and complexities which still stand in the way of a continuous phylogeny of fossil forms.

Among Zeiller's more general works may be mentioned his 'Éléments de Paléobotanique' (1900), an admirable text-book, of which a second edition would have been most welcome; his masterly summaries of palæobotanical progress during 20 years (1886–1906) §; and, lastly, his valuable sketch of advances in Mesozoic Palæobotany (1907) ‖.

Zeiller's merits were recognised in this country by the Honorary Degree conferred upon him by the University of Cambridge

* "Une nouvelle Classe de Gymnospermes—les Ptéridospermées." Révue Gén. des Sciences, August 30, 1905.

† Étude sur le *Lepidostrobus Brownii*. Paris, 1911.

‡ See especially "Les Végétaux Fossiles et leurs Enchainements." Revue du Mois, February 10, 1907.

§ Paléontologie Végétale. 1886–1893 in Annuaire Géol. Universel, Tomes iii–x. 1893–1896 in Revue Gén. de Bot., Tomes ix, x. 1897–1900 ibid., Tome xv. 1900–1906 ibid., Tomes xv, xvi.

‖ "Les Progrès de la Paléobotanique de l'ère des Gymnospermes." Progressus Rei Botanicæ, Vol. ii. Part 1.

at the Darwin Celebration in 1909, and by his election as a Foreign Member of this Society (1905) and of the Geological Society of London (1909; corresponding member 1899).

Personally, Zeiller had a great charm of manner, his dignity and courtesy winning the hearts of all his colleagues, many of whom have the pleasantest recollections of his warm kindness and hospitality. By religion he was a devout Catholic.

[D. H. Scott.]

June 1st, 1916.

Sir David Prain, C.M.G., F.R.S., President, in the Chair.

The Minutes of the Anniversary Meeting of the 24th May, 1916, were read and confirmed.

Colonel Masters John Godfery was admitted a Fellow.

Mr. Thomas William Brown and Dr. William Thomas Elliott, F.Z.S., were elected Fellows.

The President announced that he had appointed the following to be Vice-Presidents during the ensuing year:—Mr. Horace W. Monckton, Prof. E. B. Poulton, Dr. A. E. Shipley, and Dr. Otto Stapf.

Mr. Clement Reid, F.R.S., and Mr. James Groves, F.L.S., gave a demonstration of "New types of Fossil Characeæ from the Purbeck Beds." In the absence of Mr. Reid, Mr. Groves referred to the curiously isolated character of the *Characeæ* exhibiting no clear affinities with any other group of plants, and to the consequent interest attaching to any light which could be thrown on their past history. After enumerating the earlier formations in which plant-remains conjectured to belong to ancestors of the group had been found, he stated that the earliest known remains of undoubted *Characeæ* were detached fruits recorded from the Lias and Oolite, the earliest remains of the vegetative parts being those in the Middle Purbeck beds.

He explained that by Mr. Reid's method of subjecting slices of the limestone, in which the plants were found, to a prolonged drip of very slightly acidulated water, so that the Chara-remains were etched out, they had been able to elicit much fresh information as to structure, which had not been obtainable from the sections and polished surfaces of chert. Some lantern-slides and a large number of photographs taken by Mr. Reid were exhibited, with especial reference to the prevalent type of Characeous plant which had recently been described by Messrs. Reid and Groves as a new genus, *Clavator*. The principal characteristics of this were:—the constant number of the cortical tubes (12), the remarkably swollen stem-nodes developed in a peculiar manner,

the production of symmetrical rosette-like groups of small clavate processes on the stems and branchlets, and the presence of a utricle enveloping the oospore and formed or surrounded by a number of elongated adnate cells, all of which characters represented important divergencies from any existing type of Characeous plant. Reference was made to other types which had not yet been worked out, especially to a large one of which casts only had been found and a minute one evidently belonging to the section *Nitellæ*, but presenting important points of difference from existing forms.

Dr. D. H. Scott, F.R.S., and Dr. Marie Stopes discussed some of the points raised.

The next paper, by Prof. G. E. Nicholls, F.L.S., on "The Structure of the Vertebral Column in the Anura Phaneroglossa and its Importance as a basis of Classification," was read in title. (See pp. 80–92.)

Prof. Julius MacLeod, University of Ghent, followed with an account of his paper on "Quantitative Variation in certain Diagnostic Characters of ten Species of the Genus *Mnium*," which was communicated by Prof. F. E. Weiss, F.L.S.

Mr. H. N. Dixon, Prof. Weiss, and Dr. D. H. Scott discussed the paper, and the Author replied to their criticisms.

Dr. Marie Stopes, F.L.S., showed lantern-slides and sections of the "petrified cone of a new species of *Bennettites* from the English Gault."

Additional remarks were made by Dr. D. H. Scott and Prof. Weiss.

Dr. George Henderson sent seeds of the Opium Poppy from the Punjab, and of Chinese Hulless Oats, for distribution; it was stated that measures had been taken to raise these seeds, so as to test the statement of their great productiveness.

A paper by Mr. W. Lucas Distant, on the Rhynchota from the Indian Ocean, the second portion, communicated by Prof. J. Stanley Gardiner, F.R.S., F.L.S., was read in title.

The General Secretary communicated a note from Miss Louisa Pershouse, of Torquay, stating that *Mimulus moschatus* had been observed by her for several years as growing and increasing in running water near Sticklepath, in the neighbourhood of Okehampton, on the borders of Dartmoor; the name was confirmed at Kew.

The President remarked that this plant in cultivation seems to have quite lost its original musky scent, and that it would be interesting to know if this escape had retained it.

The Structure of the Vertebral Column in the Anura Phaneroglossa and its Importance as a Basis of Classification.

By Geo. E. Nicholls, D.Sc., F.L.S., Beit Memorial Fellow, Department of Zoology, King's College, London. (With 1 Text-figure.)

[Read 1st June, 1916.]

As is well known, the vertebral column of the common frog consists of nine vertebræ of which the ninth (the sacral) has a biconvex centrum. Of the eight pre-sacral vertebræ, the first seven are procœlous and the eighth has a biconcave (amphicœlous) centrum.

It is generally supposed that this condition prevails among the greater number of living Anura, and this type of vertebral column is commonly described (notwithstanding the condition of the eighth and ninth vertebræ) as *procœlous*, in distinction to that of those few primitive Anura in which the presacral vertebræ are *uniformly opisthocœlous*.

Thus Gadow states ('01, p. 19), "Procœlous vertebræ exist in the overwhelming majority of the Anura: opisthocœlous are those of the Aglossa, the Discoglossidæ, and of some Pelobatidæ." He continues (p. 20), "*the sacral vertebra, . . . in all the Anura is invariably biconvex, the eighth being biconcave in the procœlous families*" (my italics).

Now this generalization which had appeared, in almost identical form, several years earlier in Boulenger's admirable work on "The Tailless Batrachians of Europe," is, as I shall presently show, by no means correct.

The accuracy of the statement, however, appears never to have been challenged, nor even the existence of exceptions recorded until recently, when I called attention ('14, pp. 420–1) to the fact that the condition of the eighth and ninth vertebræ of *Bufo* constituted a very distinct departure from this rule.

This fact had been ascertained by the examination of all of the Bufonid skeletons in the Collection of the British Museum, this material (with my own specimens) comprising more than fifty examples representing over thirty species. In this genus the centra of all of the vertebræ are alike excepting only that the convexity (for articulation with the ensuing coccyx) upon the hinder face of the ninth vertebra is doubled in the manner that is so nearly universal among the Anura.

In *Bufo*, then, there exists a third type of vertebral column which is *uniformly procœlous*, and therefore perfectly distinct from that which has a biconvex sacral and a biconcave eighth vertebra but which, nevertheless, has hitherto been described as procœlous. It is obvious that only to such a vertebral column as that of *Bufo* can the term "Procœlous" be strictly applicable, in distinction to that of the lower Anura (Aglossa) in which the vertebral column is *opisthocœlous*.

I recommend, therefore, that the term "Procœlous" be restricted to vertebral columns of the Bufonid type in which *all* of the centra are hollow in front. For those vertebral columns, hitherto described as procœlous, which have *only the first seven* vertebral centra hollow in front, the eighth hollow upon both faces and the ninth doubly convex, I propose that the term "*Diplasiocœlous*" (which has been suggested to me by Mr. Boulenger) should be employed.

When, in 1914, I recorded the existence of a uniformly procœlous condition in *Bufo*, I assumed, mistakenly as it now appears, that this type of vertebral column might be found to be confined to that genus. That such a condition could be of widespread occurrence seemed incredible in view of the authoritative statement above quoted.

Recently, however, I have been enabled, by the kindness of Mr. Boulenger, to examine practically the entire collection of Anuran skeletons in the British Museum. This material includes, in addition to some eight specimens of Aglossa (*Xenopus lævis* [4]*, *X. calcaratus*, *Hymenochirus boettgeri*, and *Pipa americana* [2]), nearly two hundred examples of the Phaneroglossa. To these must be added about fifty specimens representing nine species which are in the teaching collections of King's College and the Agra College and in my own possession. The vertebral columns of more than one hundred and fifty common frogs (*R. temporaria*) were also examined in this connection. In all, there were examined over four hundred vertebral columns of some fifty genera of Anura.

The Discoglossidæ were represented by nearly a dozen specimens (*Discoglossus pictus* [5], *Bombinator igneus* [3], *Alytes obstetricans* [3]), and were found to be, without exception, normally opisthocœlous.

Of the Pelobatidæ, I have examined fourteen specimens of the genera *Megalophrys* (*M. montana* [2], *M. nasuta* [2], *M. feæ*, *M. longipes*), *Pelobates* (*P. fuscus* [6]), *Scaphiopus solitarius*, *Pelodytes punctatus*, and *Palæobatrachus* sp. Of these all were uniformly procœlous excepting two individuals of *Megalophrys* (*M. montana*, *M. nasuta*), which were opisthocœlous.

The families Hylidæ, Bufonidæ, and Cystignathidæ were, without exception, characterized by the possession of a procœlous (*strictu sensu*) vertebral column. The Hylidæ examined were *Hyla* (*H. venulosa* [2], *H. dolichopsis* [2], *H. gratiosa*, *H. macrops*, *H. lichenata*, *H. taurina*, *H. cærulea* [2], *H. aurea* [2], *H. faba*, *H. arborea* [3], *H. pulchella* [2], *H. maxima*, *H. versicolor*, *H. bandina*, *H. boans*), *Nototrema* (*N. marsupiatum* [2]), and *Phyllomedusa* (*P. dacnicolor* [2] and *P. burmeisteri*). Except for a single specimen of *Nectophryne hosii*, all of the Bufonidæ examined belonged to a single genus, *Bufo*. The species included *B. marinus* [3], *B. quadriporcatus*, *B. vulgaris* [8], *B. calamita* [2],

* The numerals in [ ] indicate the number of specimens of each species examined.

B. leptopus, *B. asper*, *B. vittatus*, *B. dodsoni*, *B. americanus*, *B. vallíceps* [2], *B. spinulosus*, *B. viridis* [2], *B. typhonius*, *B. carens*, *B. andersonii* [3], *B. lentiginosus* [3], *B. granulosus*, *B. regularis*, *B. raddii*, *B. tuberosus*, *B. claviger*, *B. boreas*, *B. pentoni*, *B. latifrons*, *B. intermedius*, *B. melanostictus* [4], *B. mauretanicus*, *B. hæmatiticus*, *B. superciliaris*, and *B. crucifer*. Of the Cystignathidæ, on the other hand, there were representatives of no less than twelve genera and nineteen species:—*Ceratohyla bubalus*, *Pseudis paradoxa*, *Calyptocephalus gayi*, *Telmatobius jelskii*, *Ceratophrys ornata*, *C. boiei*, *Chiroleptes australis*, *C. platycephalus*, *Heleioporus albopunctatus*, *H. pictus*, *Hylodes lineatus*, *H. raniformis*, *H. fleischmanni*, *Cryptotis brevis*, *Limnodynastes tasmaniensis* [2], *L. dorsalis*, *L. ornatus*, *Leptodactylus pentadactylus*, and *Hylorhina silvatica*. The closely related Dendrophryniscinæ are represented in the British Museum Collection by a skeleton of *Batrachophrynus brachydactylus*, which was also procœlous.

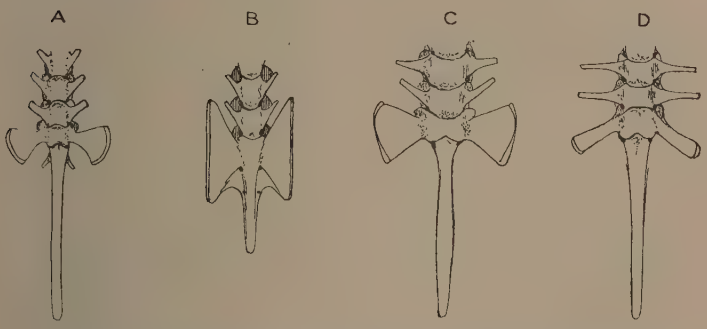
Among the forms included in the Engystomatidæ and Dyscophidæ, three specimens (representing two genera) were found to retain the strictly procœlous condition. These were *Rhombophryne testudo*, *Atelopus oxyrhynchus* and *A. ignescens*, each represented by but a single specimen. The majority of the specimens exhibit the diplasiocœlous condition, which was seen in eight genera, viz.:—*Breviceps* (*B. verrucosus*, *B. mossambicus*), *Calophrynus* (*C. pleurostigma*, *C. madagascariensis*), *Scaphiophryne* (*S. marmorata*), *Cacopus* (*C. systoma*), *Callulops* (*C. doriæ*), *Callula* (*C. pulchra*), *Hypopachus* (*H. variolosus*), and *Genophryne* (*G. thomsoni*).

Among the Ranidæ the diplasiocœlous condition also prevails, only five specimens (referred to four species of *Rhacophorus*) being found to retain the more primitive procœlous condition. The specimens of this family which have been examined include the following:—*Hylambates* (*H. angolensis*), *Trichobatrachus* (*T. robustus*), *Gampsosteonyx* (*G. batesi*), *Rana* (*R. clamata*, *R. tigrina* [35], *R. agilis*, *R. adspersa*, *R. latastii*, *R. afghana* [2], *R. montezumæ* [2], *R. catesbiana*, *R. galamensis*, *R. guttulata*, *R. fuscigula*, *R. macrodon*, *R. gracilis*, *R. cyanophlyctis*, *R. esculenta* [12], *R. grunniens*, *R. erythræa*, *R. malabarica*, *R. beccarii*, *R. pleuraden*, *R. adenopleura*, *R. jerboa*, *R. arvalis*, *R. camerani*, *R. græca*, *R. iberica*, *R. palustris*, *R. madagascariensis*, *R. boyli*, *R. ornatissima*, *R. liebigii*, *R. hexadactylus*, and *R. temporaria* [about 160]), *Rhacophorus* (*R. maculatus*, *R. cruciger*, *R. goudotii*, *R. macrotis*, *R. robustus*, *R. schlegelii*, *R. reinwardtii* [2], *R. maximus*, and *R. madagascariensis*), *Chiromantis* (*C. petersi*), *Cornufer* (*C. corrugatus*), *Oxyglossus* (*O. lævis*), *Tympanourus* (*T. newtoni*), *Oxyrhachis lævis*, *Arthroleptis* (*A. variabilis*), and *Ceratobatrachus guentheri* [2].

In by far the greater number of cases, disarticulated vertebral columns were not available, but this circumstance presented no serious difficulty since the condition of the vertebral centra can,

in almost every case, be made out with ease by a careful examination of the ventral surface of the vertebral column (see text-figure). In a few specimens in the Collection of the British Museum the vertebræ were sufficiently free to admit of an actual observation of the anterior faces of the sacral and preceding vertebræ. In every such case this examination confirmed the opinion already formed from the examination of the entire vertebral column of a specimen of the species in question. A few specimens (a bare half-dozen), concerning which I could not feel absolutely certain, were referred to Mr. Boulenger, who was able to confirm, in every case, the correctness of the conclusion at which I had, provisionally, arrived.

The result of this investigation was quite unexpected, for, as has been shown, it was found that the Diplasiocœlous ("procœlous") condition, which was supposed to characterize "the overwhelming majority" of Anura, is in fact confined to the Firmisternial forms!



Ventral view of the hinder part of the vertebral columns of (A) *Discoglossus pictus*, (B) *Pelobates fuscus*, (C) *Bufo andersonii* (all × 2), and (D) *Rana tigrina* (nat. size), to show the opisthocœlous, anomocœlous, procœlous, and diplasiocœlous conditions.

The biconvexity of the centrum of the sacral vertebra, therefore, so far from being an "invariable" feature of the Anuran vertebral column, is in fact restricted, except for individual variation, practically to the Discoglossidæ and the Firmisternia *.

On the other hand, a vertebral column in which *all* the centra are hollow in front (Procœlous, *strictu sensu*) is found in the Cystignathidæ, Hylidæ, Bufonidæ, and the Pelobatidæ, *i. e.*, the whole of the Arcifera excluding only the Discoglossidæ.

The Pelobatidæ are known to be extremely variable in the condition of the vertebral column. They are, nevertheless, excepting

* A few opisthocœlous Pelobatidæ may have a biconvex ninth centrum, which is, however, easily distinguished from those of Discoglossidæ or Firmisternia by its *single* coccygeal condyle.

for what will probably prove to be merely individual variations (*vide infra*), of the uniformly procœlous type. They differ, however, from the remaining procœlous families, in that the convexity upon the sacral vertebral centrum (for articulation with the coccyx) is single instead of double as in all other Anura.

It will be seen, therefore, that the Anura may be divided sharply into *five* groups, according to the structure of the vertebral column (and attached ribs).

(i.) Sacral vertebræ always fused with coccyx; pre-sacral vertebræ seven (or fewer), opisthocœlous: with ribs in development. (Aglossa.)

(ii.) Sacral vertebra free, with biconvex centrum; pre-sacral vertebræ not less than eight, opisthocœlous: with ribs. (Discoglossidæ.)

(iii.) Sacral vertebra procœlous, ankylosed to coccyx, or if free, with but a single condyle for articulation with coccyx; pre-sacral vertebræ eight, procœlous: without ribs. (Pelobatidæ.)

(iv.) Sacral vertebra free, procœlous, with double condyle for the coccyx; pre-sacral vertebræ eight, procœlous: without ribs. (Remaining Arcifera.)

(v.) Sacral vertebra free, biconvex; eighth vertebra biconcave; first seven vertebræ procœlous: without ribs. (Firmisternia.)

Discussion.

Earlier Views as to the importance of the condition of the Vertebral Centra as a systematic character.

As is well known, a varying degree of importance has been attached, by different authors, to the condition of the vertebral centra in the Anura. Thus both Cope ('66) and Lataste ('79) laid considerable stress upon the opisthocœlous or procœlous character. Boulenger ('82), in his 'Catalogue of the Batrachia Salientia s. Ecaudata,' made use, principally, of the condition of the pectoral girdle and of the dentition, and pointed out that the mode of vertebral articulation appeared to be of unequal importance throughout the group.

Some three years later, Blanchard ('85, p. 588) went so far as to propose that the tailless Batrachia should be separated into two principal groups, the "Opisthocœliennes" and the "Procœliennes." His suggestion did not meet with acceptance, and subsequent writers seem to have attached less and less value to the condition of the centra as a systematic character. Thus, in 1901, Gadow wrote ('01, p. 19): "The systematic value of this pro- or opistho-cœlous character has been much exaggerated." He continued (p. 20), "it is not difficult to imagine that in the Anura the production of pro- or opistho-cœlous vertebræ depends simply upon the centra or articulating knobs happening to fuse either with the hind or the front end of the vertebræ."

In 1907 Beddard pointed out that in some species of the genus

Megalophrys, which was said to be opisthocœlous, the procœlous condition actually occurred, and in the following year Boulenger, referring to this point, concluded ('08, p. 408): "It is therefore clear that this character, however important it may appear at first, is worthless even as a specific character in these Batrachians."

The Infrequency of Variation in the Mode of Vertebral Articulation.

A fact, however, which lends weight to the value of the character of the vertebral centra for systematic purposes is the extraordinary rarity of the occurrence of individual variation. In not one of at least a hundred specimens of the procœlous families Bufonidæ, Hylidæ, and Cystignathidæ (represented by over seventy species) did I find a case of individual variation in the character of the vertebral centra, although variation affecting the vertebræ in other ways was not infrequent! Indeed, so far as I can discover, only once has an abnormality affecting the centra been recorded in a member of these families, this being described by Cope ('66) in *Borborocœtes*. In the vertebral column of the Pelobatidæ individual variation is peculiarly frequent, but even in this family, very few cases of variation in the character of the centra have been met with outside of the genus *Megalophrys*.

Among the Diplasiocœlous families, also, the occurrence of individual variation in the condition of the centra is extraordinarily rare—indeed, it is almost certainly the rarest of all abnormalities. When such variation does occur it appears invariably to take the form of a reversion to the more primitive (strictly procœlous) condition. Thus, Lloyd Morgan has described one such case in the common frog, while I have myself met with two other instances of this reversion. The first of these was found in a specimen of *R. esculenta*, and the second may be seen in a specimen which is preserved in the British Museum Collection. It is labelled *Rana* sp., but is, almost certainly, *R. tigrina*. Apart from these three examples * there are, I believe, no known cases of variation in the condition of the centra in diplasiocœlous forms. Moreover, I have recently examined the vertebral column of more than one hundred and fifty specimens of the common frog, and although I find that the vertebral column is variable in 8 per cent. of the specimens examined, yet there was not one which departed from the typical diplasiocœlous condition of the centra.

The Character of the Vertebral Centra not "Adaptive."

The precise manner in which the vertebral centra articulate does not appear to be related to the habits of the various forms, that is, it cannot be described as an adaptive character. There

* An abnormal vertebral column (*R. temporaria*) described by Howes ('86) had *ten* vertebræ all of which were procœlous.

are forms which jump as powerfully or swim as strongly in the procœlous Arcifera as in the diplasiocœlous Firmisternia, just as there are crawling, burrowing, or arboreal forms in each group. A very similar statement might be made, comparing the opisthocœlous forms with the procœlous. Indeed, from the standpoint of function it would appear to be a matter of little import whether the intervertebral spheres become attached to the anterior or the posterior face of an adjoining vertebra, and, as Gadow has remarked, we might imagine that the union of these intervertebral spheres with centra before or behind would be a mere matter of chance. Occasionally, as a very rare variation in the Pelobatidæ, the intervertebral spheres altogether fail to unite with the centra and the amphicœlous (ancestral) condition of the embryo persists into maturity (*P. cultripes*, Dugès, '34; *P. fuscus*, Stannius, '54).

When, therefore, such a comparatively trivial character as this is found to occur over a wide range of genera in which there is an almost complete absence of individual variation*, we are surely justified in attaching to it considerable value as a systematic character, since its occurrence is to be explained only upon the ground of community of descent.

A division of the Phaneroglossa, based upon this character, gives us, moreover, a grouping which (while it corresponds fairly closely with that at present accepted as representing a natural classification) separates the Discoglossidæ a little more widely from the remaining Arciferous forms.

The breaking-up of the Arcifera has already been proposed by Stejneger ('07). That author divided the Anura into three sub-orders:—Aglossa, Costata (the Discoglossidæ), and Linguata (the remaining Phaneroglossa).

Lataste ('79) and Blanchard ('85) went still further and proposed the inclusion of both the Aglossa and the Discoglossidæ in the same Sub-order (Opisthocœla).

The change which I propose in our present classification consists simply in the grouping of the families of the Phaneroglossa into four larger divisions (tribes) in place of the two series, Arcifera and Firmisternia, at present recognized.

PHANEROGLOSSA.

I. Opisthocœla. Sacral vertebra biconvex, free from coccyx; pre-sacral vertebræ eight, opisthocœlous; with ribs.
Includes but one family, the Discoglossidæ.

II. Anomocœla. Sacral vertebra ankylosed to coccyx or articulating therewith by a single condyle; vertebræ procœlous (rarely opisthocœlous); without ribs.
Includes a single family, the Pelobatidæ.

* Even in the very variable Pelobatidæ only two cases of *anomalous* centra (apart from the amphicœly above mentioned) have been recorded in the procœlous species. These were described by Stannius ('54) in *Pelobates fuscus* and by Boulenger ('82) in *Xenophrys monticola*.

III. Procœla. Sacral vertebra free, articulating with the coccyx by a double condyle; vertebræ uniformly procœlous.
Includes the Bufonidæ, Hylidæ, and Cystignathidæ.

IV. Diplasiocœla (=Firmisternia). Sacral vertebra biconvex, eighth vertebra biconcave; the first seven vertebræ procœlous.
Includes the Ranidæ and Engystomatidæ.

(i.) This arrangement involves, as will be seen, the subdivision of the Arciferous forms into three groups. As already pointed out, it has long been recognized that the Discoglossidæ are somewhat more widely removed than the existing classification would indicate.

(ii.) Concerning the Pelobatidæ, Gadow remarks that they can be separated from the Bufonidæ only by the dentition. Nevertheless he advocates that they shall be retained as a distinct family. In the condition of their vertebral articulation, however, the Pelobatidæ apparently possess a distinctive character which amply justifies their separation from the Bufonidæ. That both procœlous and opisthocœlous vertebræ occur within a single genus (*Megalophrys*) has been considered as sufficient justification for altogether discarding this character for systematic purposes. As a matter of fact, however, the whole family appears to be strictly procœlous apart from this single genus. As a family, moreover, it is notable for the extremely frequent occurrence of variations in the vertebral column. Thus, Adolphi found in *Pelobates fuscus* that abnormalities in the vertebral column occurred in more than 23 per cent. of the specimens examined! As mentioned above, the two examples recorded in the Anura, in which the amphicœlous (embryonic) condition of the centra is retained in mature animals, were both examples of *Pelobates*. Nevertheless but one example (that recorded by Stannius) appears to be known of an *irregularly* abnormal condition of the centra in this genus.

In *Megalophrys*, however, variation seems frequently to extend to the centrum. In *Megalophrys parva* (*Xenophrys monticola*) Boulenger has described an anomalous arrangement of the vertebral centra comparable to the case of *P. fuscus* described by Stannius. Moreover, *M. montana* (the type species) was originally described by Cope as having opisthocœlous centra, and this type of vertebra has since been recorded in two other species (*M. nasuta*, *M. longipes*). It is now known that the procœlous condition is, even in these three species, at least equally frequent, while in the remaining eleven species, hitherto described, the vertebræ appear to be uniformly procœlous! Thus there is little reason to regard the occurrence of the opisthocœlous condition in a few specimens of these three species as other than unusually frequent cases of individual variation *.

* Concerning *Asterophrys* little seems to be recorded. Like *Megalophrys*, it has been described as opisthocœlous, but its tongue is said to be entire and adherent, and Blanchard assigned it to the Discoglossidæ.

Two other genera, *Cophophryne* (*C. sikkimensis*) and *Ophryophryne* (*O. microstoma*), which are at present placed with the Bufonidæ but which agree with the Pelobatidæ in the character of the vertebral column, should probably be included in that family. They differ from the Pelobatidæ merely in the absence of teeth and, in describing *Ophryophryne*, Boulenger remarks ('03, p. 17) that "One must regard it as on the whole nearer to the latter (Pelobatidæ) than to the true toads; another instance of the over-estimation of dentition as a character by which to define families of the Batrachia."

In *Scaphiopus* and in one species of *Pelobates* (*P. fuscus*) there appears to be an invariable fusion of the sacral vertebra with the coccyx comparable to that which occurs in the Aglossa, but in both of these Pelobatidæ the vertebræ are uniformly procœlous. A similar fusion appears to occur as an individual variation in some other species of the Pelobatidæ (e. g. *P. cultripes*, *M. nasuta*, Boulenger, '08), but even where this variation coincides with the occurrence of opisthocœlous centra there is no danger of confusion with the Aglossal condition, for, in the latter, there are never more than seven pre-sacral vertebræ.

Bombinator is the only form, outside of the Pelobatidæ, in which the sacral vertebra articulates with the coccyx by but a single condyle. Like the Pelobatidæ, too, it is notable for the frequency of occurrence of individual variations. The vertebral column can, however, be distinguished from even an opisthocœlous specimen of the Pelobatidæ by the attached ribs.

Pelodytes, which appears to lead towards the Bufonidæ, forms an exception, apparently, to the rule that in the Pelobatidæ the sacral vertebra has but a single condyle for the coccyx. According to Boulenger ('97) the posterior convexity of the centrum of the sacral vertebra is doubled in this genus. This is certainly true of the single specimen (1915, 9. 15. 5.) in the British Museum Collection. There are, however, conflicting statements upon this matter, for Gadow describes ('01, p. 161) this genus as having but a single condyle, this character being made use of to distinguish *Pelodytes* from *Leptobrachium*, which is said to have two coccygeal condyles. On the other hand, Boulenger has merged *Leptobrachium* in the genus *Megalophrys*, which has but a single condyle for the coccyx. The explanation of these apparent contradictions may be that the doubling of the condyle is, in these genera, subject to some variation.

(iii.) The Bufonidæ, Hylidæ, and Cystignathidæ are, without exception, in the species which I have examined, distinguished from the Pelobatidæ (excluding *Pelodytes*) in having the sacral vertebra provided with two coccygeal condyles. Otherwise, in the uniformly procœlous condition of the vertebræ, they closely resemble the Pelobatidæ and are sharply marked off from the firmisternial forms in which the diplasiocœlous condition prevails.

The Hemiphractidæ, however, which are included by Gadow in the Cystignathidæ, have been described as possessing opisthocœlous

centra. Whether this is an invariable condition in that genus or whether the description was based upon the examination of a variable individual, I have no means of deciding, but the only member of this family (or sub-family) which I have examined, a specimen of *Ceratohyla bubalus*, was certainly uniformly procœlous. In the former case the genus would appear to furnish a link between the Procœla and the Opisthocœla comparable to that supplied by *Megalophrys* between the Opisthocœla and the Anomocœla.

Apart, however, from this single, possibly exceptional, genus, there has been described but a single instance of the occurrence of variable centra in these three great families which comprise the majority of living Anura *.

Remarking upon the resemblance which exists between many of the Cystignathidæ and the Ranidæ, Gadow says ('01, p. 210), "young Ranidæ, before the firmisternial character is assumed, are indistinguishable from the Cystignathidæ, and the latter would turn into Ranidæ if they could be induced to consolidate their sternal apparatus." The condition of the vertebral centra, however, permits of a distinction being readily made even between these immature forms.

(iv.) The Diplasiocœlous condition (which, as already pointed out, is restricted to Firmisternial forms) is likewise extremely constant, individual variations being almost unknown. The occurrence, therefore, of two or three genera at present included in the Firmisternia, in which the diplasiocœlous condition has, apparently, not been attained, is a matter of considerable interest.

Thus, among the Engystomatidæ which, as Gadow points out (*op. cit.* p. 143), may be connecting links between the Procœla and Diplasiocœla, I find three specimens exhibiting the uniformly procœlous condition. These are one example each of *Atelopus oxyrhynchus*, *A. ignescens*, and *Rhombophryne testudo*. Having had but a single skeleton of each of these three species for examination, I am unable to say whether or no these are cases of individual variation. It is scarcely probable, however, that two specimens belonging to distinct species should both have chanced to be similarly abnormal, and it may be assumed that *Atelopus* is normally procœlous. It is not, however, surprising that we should find in one or two genera which have become firmisternial, that there is a retention of what must be recognized as a more primitive condition of the vertebral column.

A more puzzling exception is met with in the genus *Rhacophorus*, and there can be, I think, in this case, no question of abnormality or individual variation.

The genus is one in which Boulenger has merged the genus *Polypedates*, and it is represented, in the British Museum collection of skeletons, by nine specimens. Of these, four, belonging to the species *R. maculatus*, *R. cruciger*, *R. macrotis*, and *R. robustus*,

* The specimen of *Borborocœtes* described by Cope ('66).

were diplasiocœlous. The remaining specimens, *R. maximus*, *R. madagascariensis*, *R. schlegelii*, and *R. reinwardtii* [2], were uniformly procœlous. Of the five specimens but one (*R. reinwardtii*) permitted of direct observation of the vertebral faces, but Mr. Boulenger, to whom I referred the question, agreed that the vertebral articulation in these specimens is as stated.

Such a condition is apparently inexplicable in view of the fact that the *Rhacophori* are generally accepted as true Ranidæ. It is, however, of peculiar interest in view of the fact that the *Rhacophori* have not always been regarded as Ranidæ. Originally they were placed with the Hylidæ (which are of course procœlous), to which they bear a most remarkable resemblance which is, at the present time, attributed merely to convergence. How close is this resemblance may be judged from a fact recently brought to light by Stejneger ('07). This author has pointed out that the specimen originally figured by Schlegel and regarded as the type specimen of *Polypedates* (*Rhacophorus*) *schlegelii* is actually a mere variety of *Hyla arborea* (*H. arborea japonica*)! This view, he remarks ('07, p. 77), has been confirmed by an examination of the original specimen in the Leiden Museum. He figures this variety of *Hyla* as possessing the tongue typical of the Hylidæ but as having a foot which, so Mr. Boulenger informs me, is absolutely characteristic of *Rhacophorus*!

The skeletons of the several species of *Rhacophorus* in the collection of the British Museum show the coracoids united but somewhat widely separated from the weak clavicles by conspicuous and well-calcified precoracoids.

Apart from these apparent exceptions, the whole of the remaining forms, at present grouped in the Firmisternia and which I have been able to examine, are diplasiocœlous. Moreover, this character, as already pointed out, is one which, in this group as in the Procœla, is exceptionally free from individual variation.

* * * * * * *

It may, nevertheless, be objected that the occurrence of exceptions renders the character of the vertebral articulation of little value for systematic purposes. The condition of the sternal apparatus is, however, open equally to such objection. Forms with sternal apparatus as diverse as those of *Rana* and of *Hemisus* or of *Breviceps* and of *Cacopus* are all grouped together as Firmisternia. I have shown, too, in a recent paper ('15), that there is normally in *Rana tigrina* a very marked overlap of the coracoids rivalling that of many Arciferous forms.

It is obvious, moreover, that whereas the precise manner in which the intervertebral spheres unite with adjoining centra has no physiological importance, the consolidation of the sternal apparatus may well be of considerable physiological value and therefore be a character which might well arise independently in widely separated forms*.

* Cf. the existence of a consolidated sternal apparatus in the Aglossa.

This was apparently Cope's view, and Gadow suggests ('01, p. 143) that the Firmisternia may prove to be a polyphyletic assemblage.

Further, the Anura are known as a very modern and wonderfully plastic group. It is to be expected, therefore, that there should be found persisting forms which appear to connect the several groups. The difficulty that is experienced in attempting to draw hard and fast lines between the different families suggests that our classification is, in the main, a natural one and does not represent merely a convenient key as Gadow is prepared to believe ('01, p. 143).

Thus the Pelobatid *Megalophrys* with its occasional opisthocœlous centra serves as a link with the Discoglossidæ, a link which is strengthened by the invariable occurrence in the otherwise very variable *Bombinator* of but a single coccygeal condyle. On the other hand, *Pelodytes* seems to connect the Anomocœla with the Procœla. *Rhombophryne* and *Atelopus*, too, may be considered either as Procœla in which the consolidation of the sternal apparatus (foreshadowed in the Bufonide, *Rhinophryne*, and *Myobatrachus*) has become an accomplished fact, or as Firmisternia in which the Diplasiocœlous condition has not yet been attained.

I desire to take this opportunity to express my thanks to Mr. Boulenger for directing my attention to certain of the literature, and to Professor Dendy for much valuable criticism.

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LIST *in accordance with Bye-Laws, Chap.* XVII. *Sect.* 1, *of all Donations of the amount or value of Twenty-five pounds and upwards.*

1790.

The Rt. Hon. Sir Joseph Banks, Bt.
Cost of Copper and engraving of the plates of the first volume of Transactions, 20 in number.
The same: Medallion of C. von Linné, by C. F. Inlander.

1796.

The same: a large collection of books.

1800.

Subscription towards the Charter, £295 4*s.* 6*d.*
Claudius Stephen Hunter, Esq., F.L.S. (Gratuitous professional services in securing the Charter).

1802.

Dr. Richard Pulteney.
His collections, and £200 Stock.
Aylmer Bourke Lambert, Esq.
Portrait of Henry Seymer.

1804.

The Rt. Hon. Sir Joseph Banks, Bt.
His collection of Insects.

1807.

Richard Anthony Salisbury, Esq.
Portrait of Daniel Solander, by J. Zoffany.

1811.

The Rt. Hon. Sir Joseph Banks, Bt.
His collection of Shells.
Mrs. Pulteney.
Portrait of Dr. R. Pulteney, by S. Beach.

1814.

Joseph Sabine, Esq.
Portrait of C. von Linné, after A. Roslin, reversed.
Dr. John Sims.
Portrait of Dr. Trew.

1818.

Subscription of £215 6*s.* for Caley's Zoological Collection.

1819.

The Medical Society of Stockholm.
A medallion of C. von Linné in alabaster.

1822.

Bust of Sir Joseph Banks, Bt., by Sir F. Chantrey, R.A.
— Subscription of the Fellows.

1825.

The late Natural History Society.
£190, 3½ Stock.
Bust of Sir James Edward Smith, P.L.S., by Sir F. Chantrey, R.A., by Subscribers.

1829.

Subscription for the purchase of the Linnean and Smithian Collections, £1593 8*s*.

1830.

Sir Thomas Grey Cullum, Bt.
£100 Bond given up.

1832.

The Honourable East India Company.
East Indian Herbarium (Wallichian Collection).

1833.

Subscription for Cabinets and mounting the East Indian Herbarium, £315 14*s*.

1835.

Subscription portrait of Robert Brown, by H. W. Pickersgill, R.A.

1836.

Subscription portrait of Edward Forster, by Eden Upton Eddis.
Subscription portrait of Archibald Menzies, by E. U. Eddis.

1837.

Subscription portrait of Alexander MacLeay, by Sir Thomas Lawrence, P.R.A.

1838.

Collections and Correspondence of Nathaniel John Winch.
Portrait of Dr. Nathaniel Wallich, by John Lucas, presented by Mrs. Smith, of Hull.

1839.

Subscription portrait of William Yarrell, by Mrs. Carpenter.

1842.

David Don: herbarium of woods and fruits.
Archibald Menzies: bequest of £100, subject to legacy duty.
Portrait of John Ebenezer Bicheno, by E. U. Eddis, presented by Mr. Bicheno.

1843.

Subscription in aid of the funds of the Society, £994 3*s*.
Subscription portrait of Sir William Jackson Hooker, by S. Gambardella.

1845.

Microscope presented by Subscribers.

1846.

Joseph Janson: £100 legacy, free of duty, and two cabinets.

1847.

[Bequest of £200 in trust, by Edward Rudge; declined for reasons set forth in Proceedings, i. pp. 315–317.]

1849.

Portrait of Sir J. Banks, Bt., by T. Phillips, R.A., presented by Capt. Sir E. Home, Bt., R.N.

1850.

Subscription portrait of the Rt. Rev. Edward Stanley, D.D., Bishop of Norwich, by J. H. Maguire.

1853.

Portrait of Carl von Linné, after A. Roslin, by L. Pasch, presented by Robert Brown.

Pastel portrait of A. B. Lambert, by John Russell, presented by Robert Brown.

1854.

Professor Thomas Bell, £105.

1857.

Subscription portrait of Prof. T. Bell, P.L.S., by H. W. Pickersgill, R.A.

Thomas Corbyn Janson: two cabinets to hold the collection of fruits and seeds.

Pleasance, Lady Smith: Correspondence of Sir J. E. Smith, in 19 volumes.

1858.

Subscription portrait of Nathaniel Bagshaw Ward, by J. P. Knight.

Richard Horsman Solly, £90 after payment of Legacy Duty.

Subscription for removal to Burlington House, £1108 15*s*.

Biography of Carl von Linné, and letters to Bishop C. F. Mennander, presented by Miss Wray.

Dr. Horsfield's Javan plants, presented by the Court of Directors of the Hon. East India Company.

Dr. Ferdinand von Mueller's Australian and Tasmanian plants, including many types.

1859.

Books from the library of Robert Brown, presented by J. J. Bennett, Sec.L.S.

Robert Brown: bequest of two bonds given up, £200.

1861.

Subscription bust of Robert Brown, by Peter Slater.

Collection of birds' eggs, bequeathed by John Drew Salmon, F.L.S.

1862.

The Linnean Club: presentation bust of Prof. Thomas Bell, by P. Slater.

1863.

Subscription portrait of John Joseph Bennett, by E. U. Eddis.

1864.

Beriah Botfield, Esq.: Legacy, £40 less Duty.

1865.

Executors of Sir J. W. Hooker, £100.

George Bentham, Esq.: cost of 10 plates for his "Tropical Leguminosæ," Trans. vol. xxv.

1866.

Dr. Friedrich Welwitsch: Illustrations of his 'Sertum Angolense,' £130.

1867.

George Bentham, Esq.: General Index to Transactions, vols. i.–xxv.

Royal Society: Grant in aid of G. S. Brady's paper on British Ostracoda, £80.

1869.

Carved rhinoceros horn from Lady Smith, formerly in the possession of Carl von Linné.

1874.

Subscription portrait of George Bentham, by Lowes Dickinson.

George Bentham, Esq., for expenditure on Library, £50.

1875.

Legacy from James Yates, £50 free of Duty.

„ „ Daniel Hanbury, £100 less Duty.

1876.

Legacy of the late Thomas Corbyn Janson, £200.

„ „ „ Charles Lambert, £500.

George Bentham, Esq.: General Index to Transactions, vols. xxvi.–xxx.

1878.

Subscription portrait of John Claudius Loudon, by John Linnell.

Subscription portrait of Rev. Miles Joseph Berkeley, by James Peel.

1879.

Rev. George Henslow and Sir J. D. Hooker: Contribution to illustrations, £35.

1880.

The Secretary of State for India in Council: cost of setting up Dr. Aitchison's paper, £36.

1881.

George Bentham, Esq., special donation, £25.
The same: towards Richard Kippist's pension, £50.
Portrait of Dr. St. George Jackson Mivart, by Miss Solomon; presented by Mrs. Mivart.

1882.

Executors of the late Frederick Currey: a large selection of books.
Subscription portrait of Charles Robert Darwin, by Hon. John Collier.
The Secretary of State for India in Council: Grant for publication of Dr. Aitchison's second paper on the Flora of the Kurrum Valley, £60.

1883.

Sir John Lubbock, Bt. (afterwards Lord Avebury).
Portrait of Carl von Linné, ascribed to M. Hallman.
Philip Henry Gosse, Esq.: towards cost of illustrating his paper, £25.
Royal Society: Grant in aid of Mr. P. H. Gosse's paper, £50.
Sophia Grover, Harriet Grover, Emily Grover, and Charles Ehret Grover: 11 letters from Carl von Linné to G. D. Ehret.

1885.

Executors of the late George Bentham, £567 11*s.* 2*d.*
Subscription portrait of George Busk, by his daughter Marian Busk.

1886.

A large selection of books from the library of the late Dr. Spencer Thomas Cobbold (a bequest for a medal was declined).
Sir George MacLeay, Bt.: MSS. of Alexander MacLeay and portrait of Rev. William Kirby.

1887.

William Davidson, Esq.: 1st and 2nd instalments of grant in aid of publication, £50.
Francis Blackwell Forbes, Esq., in aid of Chinese Flora, £25.

1888.

The Secretary of State for India in Council: Grant in aid of publication of results of the Afghan Boundary Delimitation Expedition, £150.
Dr. J. E. T. Aitchison, towards the same, £25.
Trustees of the Indian Museum: Mergui Archipelago report, for publication in Journal, £135.
Dr. John Anderson, for the same, £60.
Wm. Davidson, Esq.: 3rd and last instalment, £25.
Sir Joseph Hooker: (1) Series of medals formerly in possession of George Bentham; (2) Gold watch, key, and two seals which belonged to Robert Brown.

1889.

Bronze copy of model for Statue of C. von Linné, by J. F. Kjellberg; presented by Frank Crisp, Esq.

1890.

The Secretary of State for India in Council: Grant for Delimitation Expedition report, £200.

Oak table for Meeting Room, presented by Frank Crisp, Esq.

Subscription portrait of Sir Joseph Dalton Hooker, K.C.S.I., by Hubert Herkomer, R.A.

Executors of the late John Ball, Esq.: a large selection of books.

An anonymous donor, £30.

Colonel Sir Henry Collett, K.C.B., towards the publication of his Shan States collections, £50.

1891.

Subscription portrait of Sir John Lubbock, Bt. [Lord Avebury], by Leslie Ward.

George Frederick Scott Elliot, Esq., towards cost of his Madagascar paper, £60.

1892.

Dr. Richard Charles Alexander Prior: for projection lantern, £50.

1893.

The Executors of Lord Arthur Russell: his collection of portraits of naturalists.

Electric light installation: cost borne by Frank Crisp, Esq.

1894.

Algernon Peckover, Esq.: Legacy, £100 free of Duty.

Miss Emma Swan: "Westwood Fund," £250.

1896.

Clock and supports in Meeting Room, presented by Frank Crisp, Esq.

1897.

William Carruthers, Esq.: Collection of engravings and photographs of portraits of Carl von Linné.

Royal Society: Grant towards publication of paper by the late John Ball, £60.

Subscription portrait of Professor George James Allman, by Marian Busk.

1898.

Sir John Lubbock, Bt.: Contribution towards his paper on Stipules, £43 14*s.* 9*d.*

Royal Society: Contribution towards F. J. Cole's paper, £50.

" " " " Murray & Blackman's paper, £80.

" " " " Elliot Smith's paper, £50.

" " " " Forsyth Major's paper, £50.

1899.

Alfred Charles William Harmsworth, Esq. [afterwards Lord Northcliffe]: Contribution towards cost of plates, £43.

Royal Society: Contribution towards Mr. R. T. Günther's paper on Lake Urmi, £50.

1901.

Hon. Charles Ellis, Hon. Walter Rothschild, Frank Crisp, Esq., F. D. Godman, Esq., and the Bentham Trustees: The Correspondence of William Swainson.

Royal Society: Contribution towards Mr. F. Chapman's paper on Funafuti Foraminifera, £50.

Prof. E. Ray Lankester: Contribution towards illustration, £30 5*s*.

Portrait of Dr. St. G. J. Mivart, presented by Mrs. Mivart.

1903.

Royal Society: Contribution toward Dr. Elliot Smith's paper, £50.

Legacy from the late Dr. R. C. A. Prior, £100 free of duty.

Mrs. Sladen: Posthumous Portrait of the late Walter Percy Sladen, by H. T. Wells, R.A.

B. Arthur Bensley, Esq.: Contribution to his paper, £44.

1904.

Royal Society: Grant in aid of third volume of the Chinese Flora, £120.

Supplementary Royal Charter: cost borne by Frank Crisp, Esq. (afterwards Sir Frank Crisp, Bt.).

1905.

Royal Society: First grant in aid of Dr. G. H. Fowler's 'Biscayan Plankton,' £50.

Executors of the late G. B. Buckton, Esq.: Contribution for colouring plates of his paper, £26.

1906.

Royal Society: Second grant towards 'Biscayan Plankton,' £50.

Subscription portrait of Prof. S. H. Vines, by Hon. John Collier.

Royal Swedish Academy of Science: Copies of portraits of C. von Linné, after Per Krafft the elder, and A. Roslin, both by Jean Haagen.

1907.

Royal University of Uppsala: Copy by Jean Haagen of portrait of C. v. Linné, by J. H. Scheffel (1739).

Royal Society: Third and final grant towards 'Biscayan Plankton,' £50.

The Trustees of the Percy Sladen Memorial Fund: First grant towards publication of Mr. Stanley Gardiner's Researches in the Indian Ocean in H.M.S. 'Sealark,' £200.

1908.

Prof. Gustaf Retzius: Plaster cast of bust of Carl von Linné, modelled by Walther Runeberg from the portrait by Scheffel (1739) at Linnés Hammarby; the bronze original designed

for the façade of the new building for the Royal Academy of Science, Stockholm.

Miss Sarah Marianne Silver (afterwards Mrs. Sinclair), F.L.S. : Cabinet formerly belonging to Mr. S. W. Silver, F.L.S.

1909.

The Trustees of the Percy Sladen Memorial Fund : Second grant towards publication of Mr. Stanley Gardiner's Researches in the Indian Ocean in H.M.S. 'Sealark,' £200.

Prof. James William Helenus Trail, F.R.S., F.L.S. : Gift of £100 in Trust, to encourage Research on the Nature of Protoplasm.

1910.

Royal Society : Grant towards Dr. G. H. Fowler's paper on Biscayan Ostracoda, £50.

Sir Joseph Hooker : Gold watch-chain worn by Robert Brown, and seal with portrait of Carl von Linné by Tassie.

Prof. J. S. Gardiner : Payment in aid of illustrations, £35 0*s.* 6*d.*

Sir Frank Crisp : Donation in Trust for Microscopical Research, £200.

The Trustees of the Percy Sladen Memorial Fund : Third grant towards publication of Prof. Stanley Gardiner's Researches in the Indian Ocean, £200. (For third volume.)

1911.

The Trustees of the Percy Sladen Memorial Fund : Second Donation towards the publication of the third volume on the Indian Ocean Researches, £70.

The same : First Donation towards the fourth volume, £130.

1912.

The Indian Government : Contribution towards the illustration of Mr. E. P. Stebbing's paper on Himalayan *Chermes*, £46 15*s.* 2*d.*

The late Mr. Francis Tagart, £500 free of Legacy Duty.

The late Sir Joseph Dalton Hooker, O.M., G.C.S.I., £100 free of Legacy Duty.

The Trustees of the Percy Sladen Memorial Fund : Second Donation towards the publication of the fourth volume on the Indian Ocean Researches, £140.

The same : First Donation towards the fifth volume, £60.

1913.

Royal Society : Grant towards Dr. R. R. Gates's paper on Mutating Oenotheras, £60.

Sir Frank Crisp, Bt., Wallichian Cabinets, £50.

The Trustees of the Percy Sladen Memorial Fund : Second Donation towards the publication of the fifth volume, £200.

1914.

Royal Society: Grant towards Miss Gibbs's paper on the Flora of British North Borneo, £50.

Miss Foot: Cost of illustration of her paper on *Euschistus*.

The Trustees of the Percy Sladen Memorial Fund: Third Donation towards the fifth volume, £10.

The same: First Donation towards the sixth volume, £190.

1915.

The Trustees of the Percy Sladen Memorial Fund: Second Donation towards the sixth volume, £80.

Miss Foot: Cost of second paper on *Euschistus*, £32 10*s*.

Royal Society: Donations towards the cost of a paper by Mrs. Arber, D.Sc., £40.

The same: towards paper on Utakwa River plants by Mr. H. N. Ridley, C.M.G., F.R.S., £50.

Miss Marietta Pallis: Instalment of cost of her paper on Plav, £30.

Sir Frank Crisp, Bt.: New shelving for Wallace's Volumes.

1916.

Mr. E. Heron-Allen: Contribution to cost of paper on Foraminifera of N.W. Scotland, £44.

Messrs. H. Takeda and C. West: Contribution towards the illustration of their paper, £40.

Royal Society: Contribution towards the illustration of two papers by Prof. Dendy, £40.

The same: Contribution towards Mr. Swynnerton's paper on Form and Coloration, £70.

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PRINTED BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

PUBLICATIONS : JULY 1915–AUGUST 1916.

Journal, Botany.

Vol. XLIII.	No. 289.	5/-
„ „	„ 290.	12/-
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Proceedings, 127th Session, October 1915. 10/-

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